WATER WORKS & SEWERAGE

L. H. ENSLOW, Editor

Vol. LXXIX, No. 7

CONTENTS for JULY 1932

LEADING ARTICLES To Appear in the Next and Subsequent Issues:

An interesting article which will appear in a coming issue deals with water supply practice and treatment for railroads. The author is R. C. Bardwell, water supply engineer, Chesapeake & Ohio Railway System.

An article of particular interest to sewage works operators scheduled for a near issue deals with sewage treatment at San Antonio, Texas. It describes the treatment works, methods of operation, and gives authentic cost data. W. E. Stanley, superintendent of sewage works, San Antonio, is the author.

Other articles scheduled for subsequent issues include the following:

"Purification of Public Water Supplies in the Orient," by Jal D. Edal Behram, chemical engineer, Bombay, India.

"A Quick and Simplified Method of Determining the Rate of Corrosion," by Cloyd M. Chapman, consulting engineer, New York City, and president of the American Society of Testing Materials.

"The Disposal of Excess Activated Sludge by Incineration," by W. M. Veitch, city engineer, London, Ontario.

"Method of Making Routine Waste Water Surveys," by E. T. Cranch, superintendent, New Rochelle Water Co., New Rochelle, N. Y.

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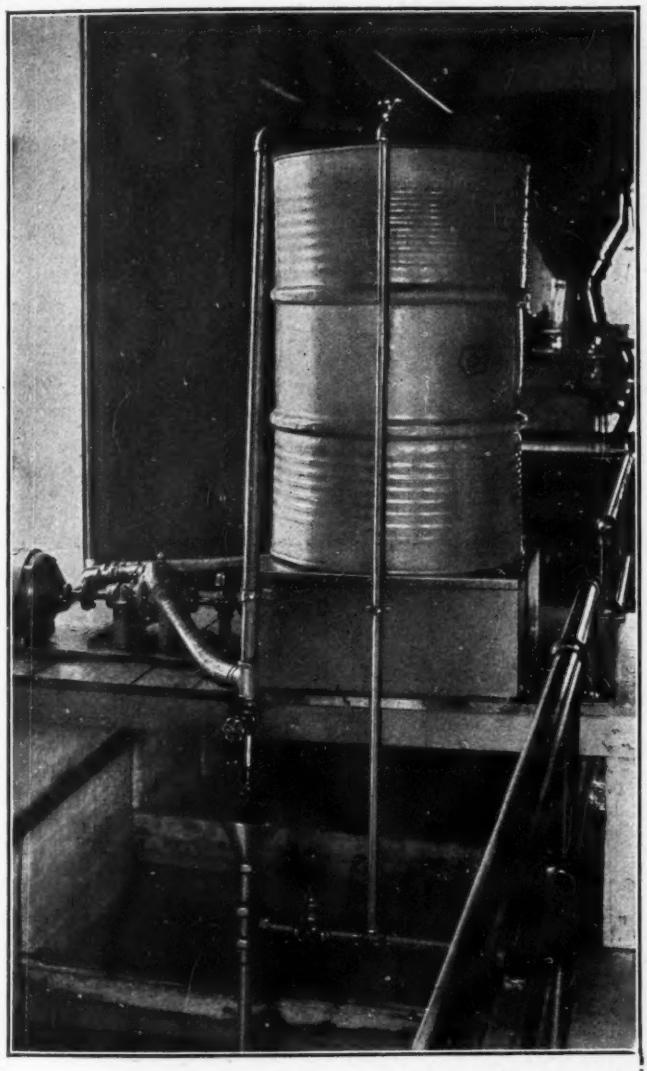
$200 A YEAR for *Complete Protection* against Tastes and Odors!



● 50-gallon oil drum with 1" ell in bottom connected to 1½" hose to pump. From pump to tee and back to tank. The motor is 1½ H.P. connected to a circulating pump from an old Willys-Knight car. This was used because of the large bearings. From the bottom of the tee is a small pet-cock that regulates the flow. This goes into a glass funnel so that you have a visual check. One pound of carbon is put into a three-gallon bucket and well mixed. It is then poured into the barrel filled with filtered water and the pump started. It flows down the pipe leading to the filters.

"This machine has been in operation a year and has given no trouble. You will notice a thrust bearing on the end. Without this the pump will wear out in a short time.

●

"Carbondale, Illinois, finds this a mighty small outlay for benefits received. No water plant operator should be without these benefits."

C. S. Gill,
Superintendent of Water Supply

Speaking at the Southern Illinois Water Operators' Conference, May 27th, 1932, Mr. Gill said:

> "'Using activated carbon is the lazy man's way of running a filter plant. You can have tastes and odors and not worry about them. You can apply too much chlorine and not have to worry about that. The carbon will take it out. You can have a poor color going on to the filters and the carbon will remedy that. Carbon is, in fact, a trouble *collector*. The more of it you use, the better the effect upon the filter effluent. *We use it all the year.* We tried stopping it in the winter, but the water lost something when it was not used."

We have quoted Mr. Gill literally but wherever the term *carbon* is used above, Aqua NUCHAR could be substituted. Aqua NUCHAR *is the only carbon used at the Carbondale plant.*

With Aqua NUCHAR and the simple apparatus pictured below, Mr. Gill has been able to relegate tastes and odors to the realm of *things that used to be.*

The coupon will bring you full information and with it a resumé of the Round Table Discussions conducted by Water Works Engineering. These discussions include a wealth of information of value to every water plant operator. Industrial Chemical Sales Company, Inc., 230 Park Avenue, New York . . . and 205 W. Wacker Drive, Chicago.

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Yes—we would like you to mention WATER WORKS AND SEWERAGE.

WATER WORKS AND SEWERAGE

JULY 1932

VOL. 79 No. 7

A GILLETTE PUBLICATION

OTTAWA'S NEW FILTRATION PLANT

By W. E. MACDONALD

Chief Engineer of Water Works, Ottawa, Canada

W. E. MacDonald

THE City of Ottawa, the capital of the Dominion of Canada, has been exceptionally fortunate in having as its source of water supply one of Canada's great rivers, the Ottawa River, which provides an abundant and excellent supply of soft water.

From 1872 to 1913, the water was supplied to the consumers without treatment but since 1913 to the present time, owing to the increased habitation on the catchment area, it has been necessary to treat the supply by the application of chlorine and ammonia.*

At various times over a period of these 20 years the question of improving the Ottawa water supply has been very much debated and many projects and schemes were submitted from time to time by eminent engineers. The subject was finally settled December, 1928, when the citizens of Ottawa decided by an overwhelming majority in favor of the adoption of the report submitted by the engineering office of the water department for the construction of a modern rapid sand water purification plant. The actual cost of the new plant was $1,526,000.

Experimental Filter

Before proceeding with the main plant, the department constructed a small experimental research filter for the purpose of determining treatment and plant design to cope with the many seasonal changes in the chemical composition, color, temperature and turbidity of the Ottawa River water. The operation of this trial plant has been the means of securing much valuable data. Peculiar features in the treatment of water have come to light, improvements and methods of treatment have been worked out which have resulted in economies in construction and operation. Most of the unknown factors have been eliminated and all the common coagulants have been studied and the necessary information obtained as to their values and costs. The information obtained in the trial plant has resulted in modification of many pre-existing ideas, and in a more efficient design of the main structure.

The New Purification Plant and Pumping Station

The site of the new 35,000,000 gallon rapid sand water purification plant and pumping station is on Lemieux Island, ½ mile up stream from the Chaudiere Falls. Actual work was commenced on the new structure on Nov. 6, 1929, when the first sod was turned. Plans for the construction of the new plant were prepared after all available data had been studied during the operation of the trial plant.

The main pumping station, a building 160 feet in length, is constructed of reinforced concrete and located directly over the suction channel, which is 20 feet in depth and extends to the full length of the building. The easterly half of the building contains three 17½ million gallon electrically operated low lift pumps, and one 35 million gallon low lift pump, operated by a 400 H.P. Diesel engine; while the westerly half of the building contains all of the high duty pumps, including two of 20

*The chloramine treatment of water was perfected at Ottawa by Joseph Race.—Editor.

A General View of "Static" Mixing Tanks

million gallons and one 17.5 million gallons capacity, all electrically driven and directly connected to two 1600 H.P. and one 950 H.P. synchronous motors.

Chemical Building

Directly to the south and adjoining the pumping station is located the new chemical building. It has been definitely proven that the Ottawa River water required an unusually heavy chemical treatment, and it has therefore been necessary for our engineers and chemists to give a considerable amount of study to the design of the chemical building to ensure proper storage and application of chemicals. This structure is of reinforced concrete and steel, four stories in height rising to an elevation of over 100 feet above the river. The chemicals are delivered by means of a vacuum conveying apparatus direct from the railway car to the four large storage bins located in the upper section of the building. These large bins provide storage for 16 car loads of chemicals, eight of sulphate of alumina and eight of lime. The chemicals will be conveyed from the large bins and hoppers to the weighing apparatus and dry feed chemical machines installed on the lower floor.

Purification Building

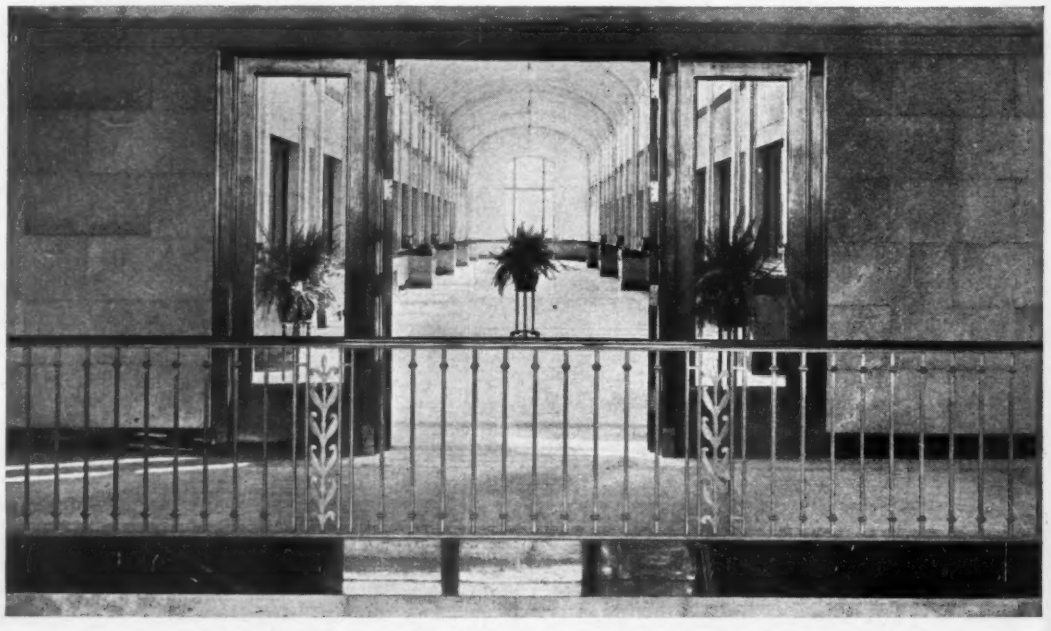
The purification building is an imposing structure; the design of the architectural features has been developed by a frank acceptance of the purpose of the various units and the expression of this idea is shown in the modern character of the elevations. This building occupies an area 464 feet by 322 feet and includes the distribution chambers, static mixing tanks, coagulation basins, settled and waste water ducts, sand filters, wash water tank, pipe and operating galleries and the filtered water reservoir.

The exterior concrete walls throughout are faced with brick and Queenstown limestone base and trim. The interior of the building is substantially finished, all materials have been selected not only for their decorative possibilities but from consideration of economy of maintenance and qualities of cleanliness. The walls of entrance hall and main stairway of the administration building are of Hauteville marble with cobweb veined black and gold trim and Roman travertine floors. The rosetta marble dado in filter gallery conceals the heating units and the filter equipment of operating tables. The bronze clock, rate of flow gauge, wash water tank-level indicator and automatic signal lights are erected on the spandrel over the entrance to main operating floor. The filter operating tables are of French rosetta and Italian valtournache marble and are equipped with specially designed bronze loss of head and rate of flow instrument cases of a style in keeping with the architectural character of the building.

The Sand Filters

The filter building proper is located immediately west and adjoining the mixing and settling tanks, being separated only by the presence of the settled water and waste ducts. The pipe and operating galleries are both situated in the center of the building and five rapid sand filters, each having an area 27 ft. by 35 ft., are constructed on each side of the galleries. Each of the ten units has a capacity of 3,500,000 imperial gallons per day.

The filters are constructed as rectangular concrete



The Operating Gallery, Viewed from the Entrance

Interior Pump Station, Showing Three Electric and One Diesel Driven Low Lift Units

tanks and contain an improved form of underdrain system and collecting laterals. These consist of 56 4-in. cast iron pipes placed at 1 ft. centers and contain many hundred three-quarter inch phosphor bronze orifices drilled in the underside of collecting laterals every 12 ins. The 4 in. laterals are installed parallel to the main gallery and are connected at the center of the filter bed to 6 inch cast iron tees, which are installed in the top section of the 36 in. rectangular effluent conduit which extends from the rear ends of the filters to the pipe gallery.

The gravel bed consists of quartz gravel, the finer grades being procured from Cape May, N. J. The bed including the ⅛th to 1/16th in. gravel is made up of five layers, the total depth being 20 ins. Sand was procured from Cape Cod, Mass.; has an effective size of 0.5 m.m. and a uniformity coefficient of 1.6. The depth of bed is 34 ins.

Filtered Water Reservoir and Wash Tank

The filtered water reservoir is constructed upon the solid rock immediately below the sand filters and occupies an area 376 ft. by 132 ft., and is 25 ft. in depth, having a capacity of 6 million imperial gallons of filtered water. Over the entire clear water reservoir there is constructed a reinforced concrete slab containing the sand filters, and filtered and wash water ducts, the pipe and operating galleries.

The wash water tank of 250,000 imp. gallons capacity is placed directly above the mixing tanks and is of special moisture proof construction and supported by large concrete columns rising from the lower elevation of the settling tanks.

Coagulation and Sedimentation

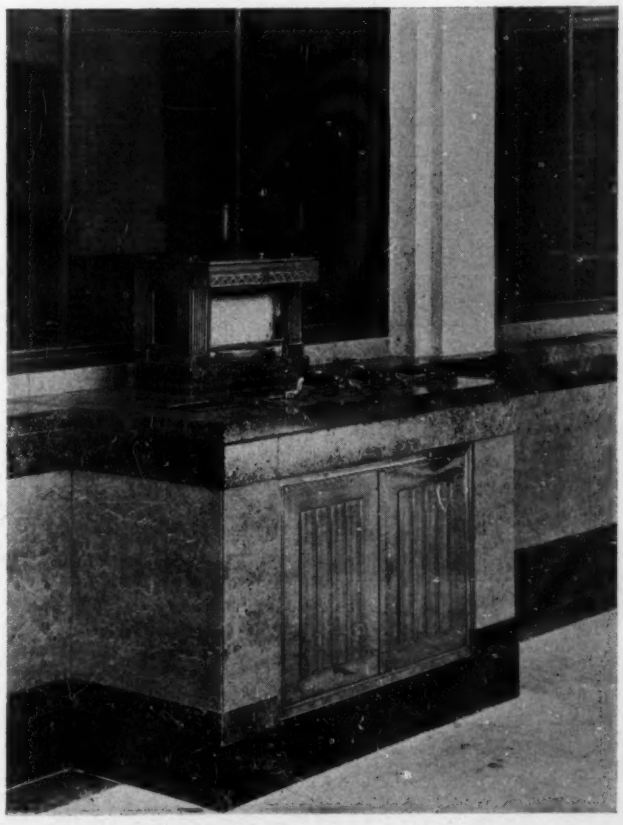
The raw water from the river passes through revolving screens and flows to the intake suction channel of the new pumping station. At the entrance of the suction channel the water is chemically treated by the application of a solution of sulphate of alumina, and then pumped through the 66 in. steel influent conduit, Venturi meter and three-way branch to a height of 42 ft. to the concrete distribution chamber in the purification building.

The raw water coagulates best in a zone of pH value between 5.1 and 5.4. The color of the raw water is normally between 75 and 84 parts per million and it has a hardness of only 20 parts per million with alkalinity slightly lower.

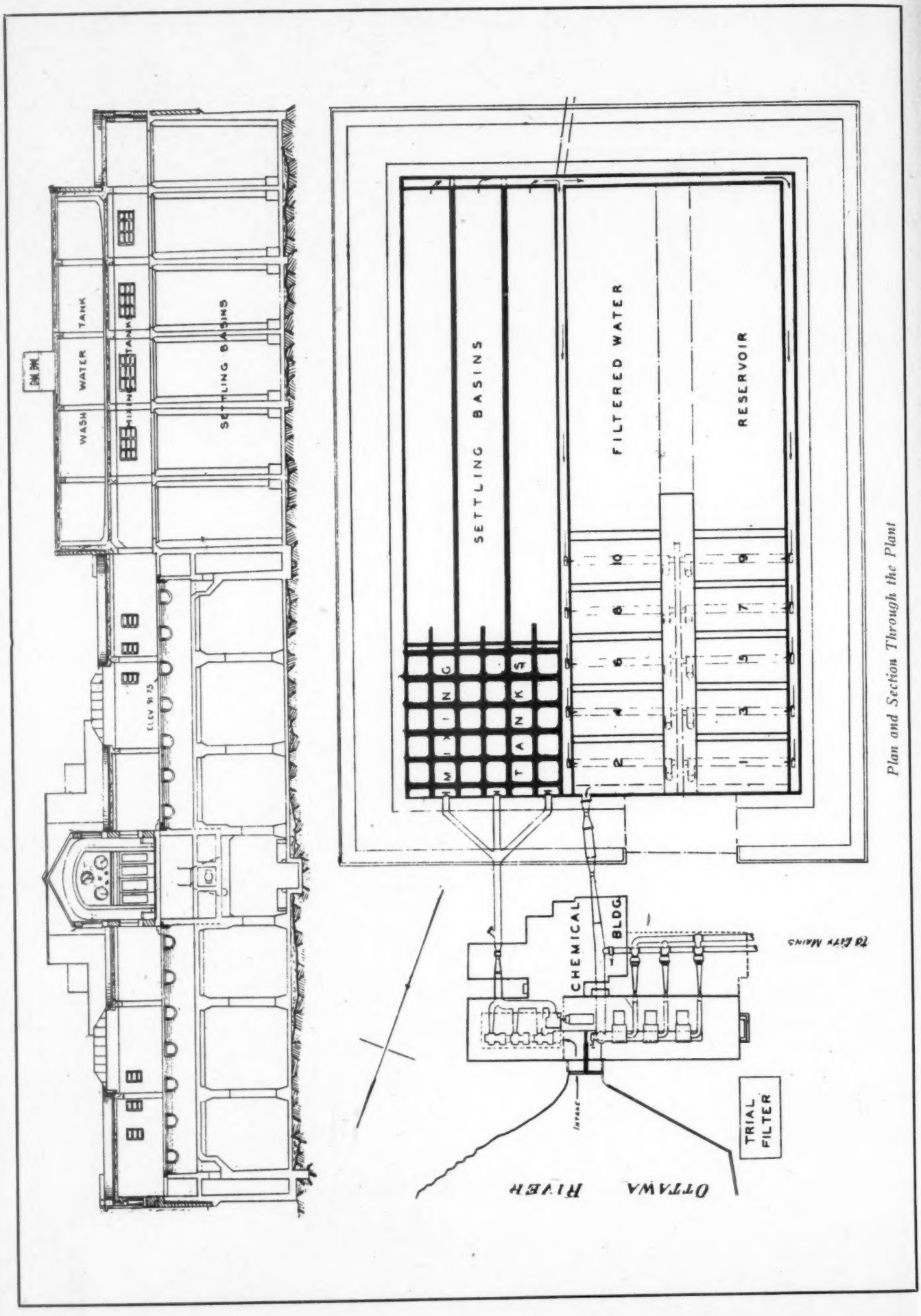
The water enters these three distribution or stilling chambers at the bottom, rises to a height of 30 ft. and flows through rectangular openings at various levels to duplicate distribution chambers. The water then passes through large ports and enters the mixing tanks at the highest elevation and is made to flow in a downward spiral direction to a second opening 30 ft. below, there it enters the second mixing tank at the bottom. In this chamber the flow is reversed and the water is forced to travel upwards 30 ft. in the form of a spiral and then enters the second series of mixing chambers. Here the flow is continued in a similar manner to that of the first series of chambers. The method of mixing is known as a "low velocity static agitation" and was developed in the trial plant.

The type of static mixing basins designed and constructed in this plant have been the result of much experimental work and they are radically different from the usual form of mechanical mixing tanks so generally adopted in other cities in recent years. The process of mixing requires a matter of some 40 minutes to produce the desired floc and the coagulated water is admitted into stilling chambers where the direction of flow is altered from a spiral to the 2,000,000 gallon settling basins. In these the water slowly moves southward to permit of the settling out the coagulated matter.

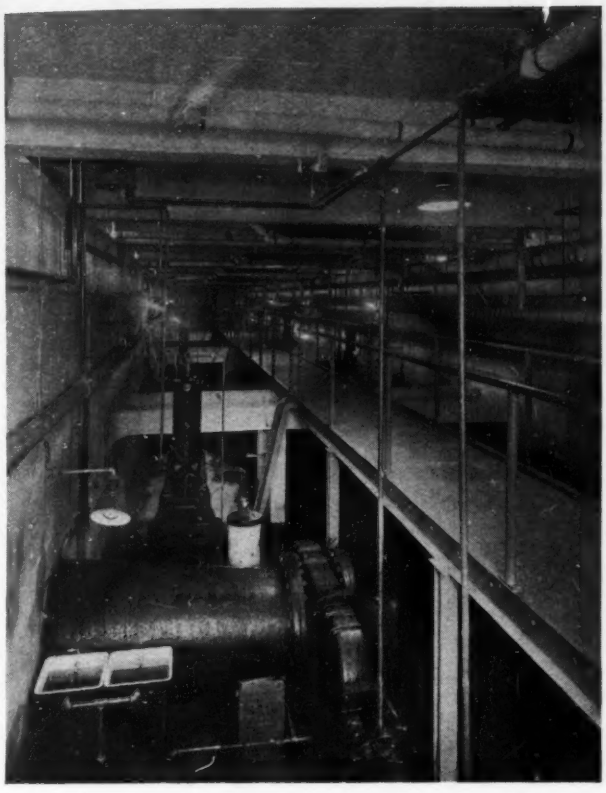
A three hour period of retention is required in the settling basins before the water flows over the collecting weir at the south end of basins and into the settled water duct. In this particular plant, to prevent damage to the delicate floc, it has been necessary to provide for abnormally large filter influent ducts so that the velocity can be maintained under 1.5 ft. per second. These two concrete ducts are located on the two outside walls of the main plant and convey the treated water by gravity to the inlet sluices of the ten rapid sand filters.



One of the Filter Control Tables, with Specially Designed Recording Gage by the Builders Iron Foundry Co.



Plan and Section Through the Plant



The Pipe Gallery

Novel Filter Rate Control —Variable and Automatic

In the pipe gallery there are installed ten separate automatic rate controllers to control the rate of flow at all times through the sand filters. The plant has been designed to produce filtered water at the standard rate of filtration which is equivalent to 108,000,000 imperial gallons per acre per day.

Since the rate of pumping into the distribution system varies greatly over the 24 hour period, it is esential that provision be made to vary the rate at which filtered water is supplied to the clear water reservoir. In most filter plants the common practice is to manually adjust each individual controller in accordance with the consumption of water but in the new Ottawa plant special attention has been given to this phase of filter operation and the result is, that with the assistance of the Builders' Iron Foundry engineers, we have designed and installed what is known as an automatic master controller to constantly regulate the rate of filtration of all ten filters so that the rate of flow will automatically be governed by the level of the water in the clear water reservoir but will be uniform through each of the units in service. In addition, the master control feature can be operated manually at will.

Method of Backwashing

In the main operating gallery of the plant there are installed ten filter operating tables. These tables are equipped with rate of flow and loss of head gauges and controlling levers to all hydraulic valves. When it becomes necessary to clean a filter, then that unit is temporarily taken out of service by the closing of the 16 in. influent and 18 in. effluent valves and then gradually opening the 36 in. valve on the wash water line.

A high velocity backwash is used in these filters wherein a 30 in. vertical rise per minute is used in cleansing the sand. The time required for backwashing usually takes from four to six minutes. However, definite instructions are conveyed to the operator, electrically by the flash of an amber light mounted on the spandrel over the main entrance as soon as a definite quantity of wash water has been consumed, this quantity having been previously determined by the chemist in charge as that necessary for a good cleansing of the beds.

To ensure efficient cleansing of the sand, we gave considerable study in the experimental plant to the mechanical construction of the strainer system, the method of distributing the wash water and the manner of agitating the sand. In the Ottawa plant we have departed from the usal form of under drain laterals and have reduced the number of orifices but have constructed the orifices of larger diameter. This we have proven will result in a more vigorous cleansing of the sand under Ottawa conditions.

Chlorination

To date chlorination of the effluent only, has been practiced. Bleaching powder has been replaced by liquid chlorine in the new plant and ammonia has been discontinued temporarily at least. Ottawa has for years used bleaching powder and ammonia for the purpose of chloramine production prior to introduction into the water.

Design and Supervision

The design, construction and supervision of the entire plant has been carried out under the direct control of the writer. The firm of Messrs. Gore, Nasmith & Storrie, Consulting Engineers of Toronto, were retained to prepare the plans and specifications and to act as consultants during the operation of the trial plant.

The operation of the trial plant and the actual supervision of construction of the new purification plant has been under the direct charge of A. D. Stalker, the resident engineer.

Stairway Showing the Artistic Interior Appointments

JOINT MEETING CENTRAL STATES SEWAGE WORKS ASSOCIATION AND ILLINOIS ASSOCIATION OF SANITARY DISTRICTS

THE Central States Sewage Works Association and the Illinois Association of Sanitary Districts held their meetings jointly this year at Rockford, Ill., May 13th and 14th. The registration totalled 204. Following the custom of the last named association a new plant was dedicated and officially opened. This year it was the plant at Rockford.

L. F. Warrick presided as President of the Central States Sewage Works Association and **G. J. Boehland** occupied the chair for the Association of Illinois Sanitary Districts.

Two Important Resolutions Passed

Of the resolutions passed by the Central States Association the two following are of particular importance at this time.

Referring to the recent deaths of E. W. Roberts, Consulting Engineer, with H. P. Jones & Company of Toledo and E. I. Arnholdt, Assistant City Engineer, of Lima, O.—both due to gas poisoning in a sludge sampling manhole at the new Lima (O.), Sewage Works, the following resolution was passed:

"That the Association go on record as urging adequate precautions against similar accidents by the proper ventilation of manholes and other enclosed spaces subject to the presence of sewage gases, and as urging the maintenance of gas indicators, gas masks and suitable rescue equipment for instant use at all sewage treatment works."

The other important resolution had to do with the feeling of the need that cities have to economize somewhere in municipal budgets and the possible dangers from curtailment of sewage treatment. The resolution in full follows:

RESOLUTION

Whereas, The Central States Sewage Works Association in its Fifth Annual Convention assembled is gravely concerned over the critical condition of sewerage works and stream sanitation throughout the country, which is arising from the stoppage of normal improvements, postponement of needed betterments and drastic curtailments of operating staffs, and by the large increase in unemployments due to vanishing construction work, and,

Whereas, Said Association finds that public health, community welfare and property are being jeopardized by sewerage works crippled for meeting normal demands, or by complete lack of suitable means for the proper removal and for final disposal of sewage where such are urgently needed, and,

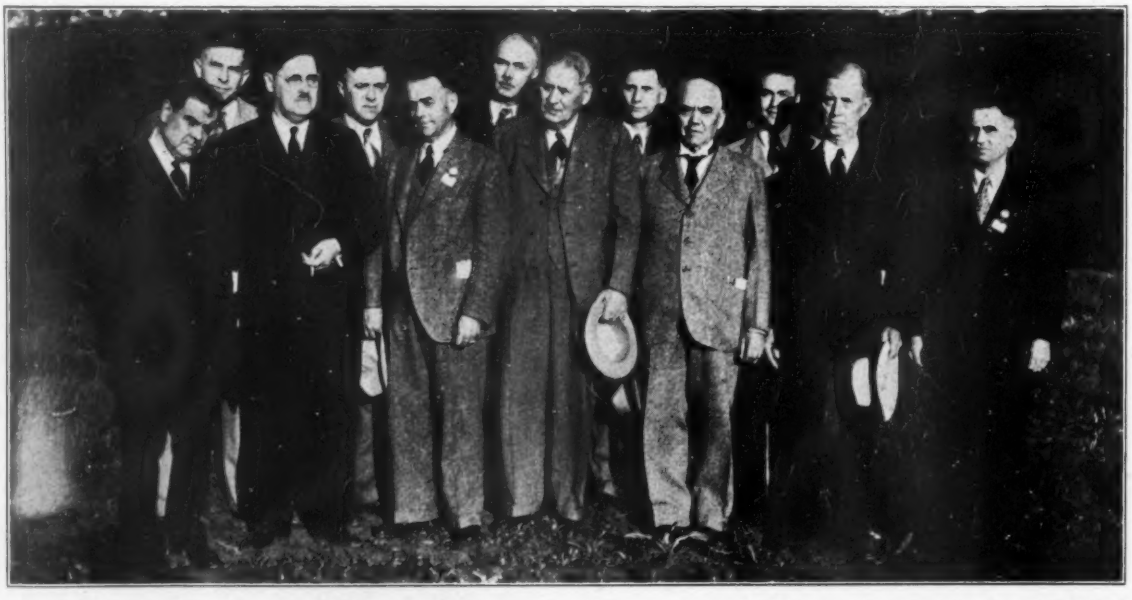
Whereas, The lag in normal sewerage works construction amounts to many millions of dollars which cost can be supported by relatively low and reasonable charges for the service rendered, and,

Whereas, Many of these improvements are already planned and can be started without delay, thus offering a ready opportunity to create large scale employment on sound public work of nation-wide distribution, thus equitably allocating the buying power which would thus be created, and,

Whereas, Said Association finds that public opinion led by private financial and investment services, in concert with wholesale measures to reduce taxes, has caused the abandonments of sewerage works projects already authorized, and the refusal to finance or even consider new projects regardless of their merits or the resulting loss in public health, property and community welfare;

Therefore be it resolved by the Central States Sewage Works Association that citizens and local, state and federal governments be urged to take prompt and effective action to:

1. Revive current enlargement and betterment construction of sewerage works.
2. Maintain adequate and efficient service by insisting on continuance of normal operating staffs of experienced men.
3. Initiate needed improvements to adequately protect public health community welfare and property and save streams and other bodies of water from undue pollution.
4. Provide means for assuring adequate credit at reasonable rates to sewerage works enterprises of established merit.



Officials of the Illinois Association of Sanitary Dis trict and Central States Sewage Works Association Dedicate the new Rockford Treatment Works.

Left to Right: Dr. J. Gordon; M. A. Kjellgren; G. J. Boehland, President I. A. S. D.; F. N. Johnson; Judge F. E. Carpenter; A. S. Anderson; H. F. Ferguson, Chief Engineer, Illinois State Department of Health. Rear Row, Left to Right: Frank Maynard, Attorney; Gus Radebaugh, Secretary C. S. S. W. A.; S. A. Greeley, Consulting Engineer; E. D. Westberg; L. F. Warrick, President C. S. S. W. A., and Chief Engineer Wisconsin Department of Health.

Annual Banquet

The annual banquet was attended by 192 persons —L. F. Warrick and G. J. Boehland dividing honors as "Toastmaster." Hon. J. H. Hallstrom, Mayor of Rockford, made the address of welcome.

"Stream Sanitation the Challenge of Our Times," was the subject of a talk made by Dr. C. A. Harper, State Health Officer of Wisconsin, and the interesting title, "Where Are We?" was dealt with in an address by W. W. De Berard, Western Editor of "Engineering News Record."

New Officers

Lewis S. Finch, Chairman of the Nominating Committee, reported the following new officers:

President—C. K. Calvert, Indianapolis, Ind.
1st Vice-Pres.—H. F. Ferguson, Springfield, Ill.
2nd Vice-Pres.—M. Starr Nichols, Madison, Wis.
Sec'y-Treas.—G. H. Radebaugh, Urbana, Ill.

The meeting place for 1933 will be at some city in Indiana, to be named by the Executive Committee.

Technical Papers Presented at the Joint Sessions

"A Quarter Century of Progress in Sewage Treatment," by **Langdon Pearse,** Sanitary Engineer, Chicago Sanitary District.

Mr. Pearse said that he would limit his remarks to progress in sewage treatment in the Chicago Sanitary District, which he had observed since 1903 and more closely so since 1909 when he became associated with the District.

The first steps had been preliminary tests on the sewage and the many trade wastes to determine the most satisfactory methods of handling them. After these studies were completed the general program of the district was shaped. This program was outlined in some detail as to its growth and development up to the present time. The latest progressive step had been the construction of a $200,000 experimental plant for the incineration of sludge. He said that the future was somewhat clouded by the present financial problems incident to poor tax collections and inability to sell bonds, all of which has resulted in halted construction and reduced operating staffs, at Chicago. He concluded by expressing his appreciation of the excellent work of Dr. F. W. Mohlman, Chief Chemist of the District.

"Sewage Disposal Trends in the Region of New York City," by **Geo. W. Fuller,** Consulting Engineer, New York.

Mr. Fuller's paper was read by **F. G. Cunningham,** a member of Mr. Fuller's organization. His paper presented a picture of the great diversity of needs and the variety of remedial steps necessary in a city where three states are involved. The steps of progress were outlined as beginning in 1898 and carried to the present time when the proposed Interstate Commission, with its requirements for treatment, is coming into being. This Commission plan has been ratified by New York, is pending before the New Jersey legislative and will go to the Connecticut Legislative in 1933. The total proposed plans for the whole New York City area involves the expenditure of $373,000,000 and building 33 plants.

"The Rock River Clean-Up Program," by **Adolph Kanneberg,** Chairman, State Commission on Water Pollution, Madison, Wisc.

Mr. Kanneberg said that the beginning of the nation-wide stream cleansing program came from the growing sentiment against pollution destroying the usefulness of streams. The development of the Wisconsin Commission on Water Pollution was reviewed with its technical, legal, economic and public interest phases. In their work and study of drainage basins to reach decisions concerning the treatment of sewage and other wastes they had always attempted to accomplish the greatest good to the most people. The Rock River project was then discussed in detail. In this case, as in all others, the climate, manufacturing projects, the agricultural interests, recreation and summer resorts all had to be considered before any definite program was decided on.

In discussion: **L. F. Warrick** stated that in each of these papers there had been reference to financing sewage plant operation and that the plan of sewer rentals was being advanced in numerous localities. He mentioned Ohio cities in particular and called on M. W. Tatlock of Dayton for remarks about its use there. **Mr. Tatlock** gave the plan briefly and recommended it very highly. **Mr. Greeley** stated that at first glimpse the plan was easily comprehended and very readily given approval. He wondered how funds should be allocated as to fixed charges and operating costs after they are raised and also whether there should be special rates for large producers of sewage. No one replied.

Papers Presented Before the Central States Association

"The Hourly Variation in Sewage at Indianapolis," by **C. K. Calvert,** Superintendent, Sewage Disposal, Indianapolis, Ind.

Mr. Calvert's paper was reviewed briefly by L. S. Finch. The hourly variations in Indianapolis sewage were given with the statement that the strongest sewage instead of the average, should be used as a basis for basic plant design data. He also showed how these peak loads are definite enough to be followed on down the stream into which they are discharged.

"Sewage Works Cross Connections," by **L. S. Finch,** Chief Engineer, Indiana State Department of Health, Indianapolis, Ind.

Mr. Finch presented a vivid picture of the many dangers arising from cross-connections between public water supplies and sewerage systems; this is even a problem in ordinary house plumbing if it is not properly installed. He also pointed out how thoughtlessness could cause pollution without any definite connection between the two systems.

Langdon Pearse stated that in Chicago there was an absolute divorcement between the two systems at the sewage works. They employ water storage tanks with ball float valve controls.

"Operating Problems at the Galesburg Sewage Treatment Works," by **L. W. Hunt,** Superintendent, Sewage Treatment, Galesburg, Ill.

Mr. Hunt said that most of his operating problems were caused by construction work not being complete and a combination of flood prevention work with sewage disposal. His biggest problem had been what to do with 40 per cent sludge in the digestion tanks. He explained this was mostly clay which had come in through the trunk sewer when a small creek had been diverted into it during its construction. He also outlined laboratory control tests employed.

M. W. Tatlock asked for an opinion as to what was the recognized method of determining pH of sludge and stated that Dayton experiences indicated

Sewage Treatment Works of the Sanitary District of Rockford, Ill., Sedimentation—Separate Digestion Plant, with Grit Removal Devices and Sludge Drying Beds—Pumping Station on Left.

quite a variation in results, depending on the procedure followed.

W. D. Hatfield stated that the pH of sludge was governed by its CO_2 content and that any handling which caused a loss of CO_2 would raise the pH. These remarks led to a question as to the need for improved standard methods for sewage analysis.

"Calculating Trickling Filter Loadings," by **E. J. Beatty,** Assistant Engineer, Wisconsin State Department of Health, Madison, Wis.

Mr. Beatty gave design loadings and efficiencies for twelve sewage sprinkling filters in Wisconsin and compared these with the data reported for eight Ohio plants by B. F. Hatch, in WATER WORKS AND SEWERAGE for November, 1931, the Wisconsin plants showing heavier loadings than the Ohio filters had received. In general the data indicated that on the average the filter efficiencies in terms of B.O.D. reduction were not affected by continuous sewage application of 1.6 m.g.d. and performance holds up with a variation of loadings within reasonable limits. Other data had shown no uniformity of reduction in efficiencies with increased strengths of the applied sewages. When loadings had exceeded 6 pounds of 5 day B.O.D. per 1,000 cu. ft of stone there appeared to be on the average, for Wisconsin plants, some reduction in efficiencies. Expressed in pounds of 5 day oxygen demand value per acre, of a 6 ft. deep unit, the limit seemed to be 1,800 lb. per acre, or equivalent to 6.5 lb. per 1,000 cu. ft. Mr. Beatty said, that he had concluded from the studies that variations in rates of sewage application or strengths, within reasonable limits, did not affect the efficiencies of individual filters studied. To insure 80 per cent or higher B.O.D. removal, for conditions met at an average plant, the loadings should not continuously exceed 1.6 m.g.d. per acre on a 6 ft. filter. An alternate requirement would be that the loading should not exceed 6.5 lb. of 5 day B.O.D. per 1,000 cu. ft. of stone in a 6 ft. filter—i.e. 1,800 lb. per acre per day.

Mr. Stanley asked Mr. Beatty if curved lines could not have been drawn through the given points as well as straight line graphs and suggested that maybe too many liberties had been taken with the known facts when so little was known of all the factors. He asked how 80 per cent efficiencies could be expected without consideration of temperatures. **Mr. Hatfield** agreed that temperature played an important part in filter efficiency and stated that at Decatur he expected 80 per cent efficiency at 80° F., 70 per cent at 70° F., etc. **Mr. Wisely** of the Illinois Department of Health, stated that in winter months, Illinois plants obtained better than 80 per cent efficiency at loadings above 1,800 lb. of oxygen demand per acre per day. **Mr. Nichols** thought filter stone size to be an important factor and that inhibitory wastes in sewage were as important as the lbs. of oxygen demand per acre per day or the depth of the filter.

Grease Skimming Devices

"Grease Skimming Basins for Sewage Treatment Works," by **S. A. Greeley,** Consulting Engineer, Chicago, Ill., and **C. C. Larson,** Superintendent, Sewage Treatment, Springfield, Ill.

Mr. Greeley stated in the joint paper that the effect of grease on the rate of biochemical activity was not definitely known, but it was considered to be inhibitory and therefore it was advisable to remove all the grease possible. He explained how the grease basin was made possible at Springfield by the need for an equalization of sewage flow into their different plant units—the effluent from the grease basin being discharged over identical weirs into the two conduits leading to other units. **Mr. Larson** then explained the operation of the basin, stating that it did remove the grease very satisfactorily and entirely justified its installation:

"Operation of the Sewage Treatment Plant at Grand Rapids, Mich., by **N. G. Damoose,** Chemist, Grand Rapids Sewage Works.

Mr. Damoose described the Grand Rapids plant and operation procedures developed. The process of sludge drying in a rotary drier, subsequent grinding, bagging and sale of the material locally as "Rapid-gro" fertilizer was particularly interesting. The fertilizer "factory" is a production of Mr. Jas. Rumsey, Superintendent, Sewage Works, and has been constructed mostly of "spare-parts" of mill machinery at a very low cost. The operation of this plant more

than pays the operating and amortization costs. The sludge dried is that taken from the sand beds.

Sludge and Gas

"Chemical and Physical Characteristics of Sludge," by **D. Althausen** and **A. M. Buswell,** University of Illinois, Urbana, Ill.

The studies reported have been conducted under the Fellowship of the Chemical Foundation of America and were made to determine the dewatering characteristics of raw and digested sludges. The results of the study had indicated that when dewatering under increasingly higher pressures there was a limit beyond which water could not be extracted. That seemed to be equal to the amount of water that any particular sludge, after drying at 100° C., would absorb again on being wetted. The better digested the sludge the more rapidly and easily the maximum extraction of water took place. These observations might lead to the perfecting of a method of determining the degree of digestion of a sludge sample within 30 minutes.

"Grease Solvents for Sludge Extraction," by **O. J. Knechtges** of Madison, Wis.

Reporting on the varying percentages of "grease" content as found in a single sample of sludge when various solvents had been used, it seemed to be the consensus of opinion by those discussing Mr. Knechtges' data, that the laboratory should continue to use petroleum ether in preference to ethyl ether, chloroform or other solvents which apparently dissolved materials other than the true fats or greases.

"The Removal of Suspended Matter and the Gas Production by Imhoff Tanks at Decatur, Ill.," by **W. D. Hatfield,** of the Decatur, Ill., Sanitary District.

Dr. Hatfield said that the Imhoff tanks at Decatur for the past four years (at a 10 m.g.d. flow of sewage) had been reducing suspended solids from 200 p.p.m. in the crude to 90 p.p.m. in the tank effluent—56.5 per cent reduction. The average sewage temperature was high (75° F.) at Decatur because of industrial (corn-products refining) wastes. A total of 9,500 lb. (average) dry solids had been removed daily by the Imhoff tanks. The gas produced in the Imhoff tanks had varied between 4.5 and 6.5 cu. ft. per pound of solids.

"Preparation and Profitable Sale of Digested Sludge for Fertilizer," by **M. W. Tatlock,** Superintendent Sewage Treatment Works, Dayton, O.

Mr. Tatlock said that their experience at Dayton had indicated that dry digested sludge could be marketed successfully, but that it required work to put it over. Tobacco had been very effectively fertilized with Dayton sludge sold to the growers.

Sludge handling economy starts at the drying beds and although a sludge of 80 per cent moisture can be handled, one with 65 per cent water handles better and far more economically. Replacing sand removed by adhering to the wetter sludge is a large item of sludge handling cost. Sludge is forked over and carried to the dump 800 ft. distant by gasoline locomotive train of sludge cars. About 63 per cent reduction in the cost of sludge cake removal had been effected by hiring a more efficient foreman to operate the locomotive and replacing 6 tine forks with forks of 14 tines. Sludge left in the glass covered houses had dried to 10 to 15 per cent water content and was ground through a wheat threshing machine. In the Fall of 1931 a hammer mill had been used and the sludge screened and bagged. Sixty tons of the material were sold and since then 475 tons had been thus disposed of. Locally the price at the plant is $1.00 per cwt. or at $15.00 per ton for large orders. The wholesale price to distributing agents is $8.50 per ton.

An old asphalt mill had been converted into a drier and now one ton of fertilizer per hour can be produced from sludge cake containing 40 to 45 per cent moisture. The hammer mill grinds the dried material containing 8 to 10 per cent water. The net profit to date had been roughly $1,400 in 1932 on an investment of $1,069 for equipment to do the work. The sludge salesmen are highly enthusiastic and 200 tons are on order now for use on tobacco this summer.

"The Development of Power from Sewage Sludge Gas," by **W. B. Walraven,** Sewerage Engineer, Springfield, Ill.

Sewerage Treatment Works of Sanitary District of Rockford, Ill. Sludge Beds and Earth Covered Digestors and Sludge Storage Tanks in Rear on Right.

Mr. Walraven outlined an ideal power development and heat utilization scheme which had been worked out as a proposed installation at their (Springfield) treatment works in which a gas engine of 175 B.H.P. was to be used and the exhaust heat transferred by water through coils in the digesters would prove ample to maintain satisfactory digesting temperatures. Of the total heat required (20.5 B.T.U. per day) he figured that about 40 per cent was that represented by radiation losses when the differential between the temperature of inlet water and outlet water through the coils was 30° F.

Mr. Walraven has prepared a printed circular descriptive of the proposed scheme and it contains data valuable to engineers considering gas power utilization.

Langdon Pearse of Chicago and **Jas. Brower** of Milwaukee said that they had been impressed with Mr. Walraven's presentation, which was ingenious and that it offered food for thought in that it was economical and utilized most all of the heat developed in producing the power.

Industrial Waste Disposal

"Practices in Industrial Waste Disposal at Milwaukee," by **H. M. Heisig,** Chief Chemist, Milwaukee Sewerage Commission, Milwaukee, Wis.

Mr. Heisig said that the Milwaukee Commission had made studies of and evaluated the various trade wastes of Milwaukee and gave a list of requirements set up by the Commission as to the degree of treatment required for each. They had concluded that such wastes were a nuisance if not detrimental to sewers and the sewage treatment process at Milwaukee and therefore should be eliminated from the sewers. The requirements of industry which had been set up are: (1) Removal of all solids tending to settle out and cause trouble in the sewers; (2) Active chemical substances must be destroyed before discharge into sewers; (3) All oil and grease must be kept out of sewers; (4) materials that might result in injury or death to employees at the plant must be removed; (5) all water not contaminated must be diverted from the sanitary sewers, and (6) **Any material** whatever, that affects the activated sludge process or plant operation, must be removed from the wastes **at their source.**

"The Attitude of Industry Toward Stream Pollution," by **C. M. Baker,** Engineer, American Pulp and Paper Association, Madison, Wis.

Mr. Baker said that "Industry" had come to concede a great deal to public opinion, but at the same time it felt entitled to the economic and proper utilization of a stream in waste disposal, provided it can be done without nuisance, property damage or menace to health. "Industry" believing that stream-pollution must and should be controlled stands ready to cooperate in any **rational** program which is not too costly.

Incineration of Grit and Screenings

"Proposed Disposal of Grit and Coarse and Fine Screenings by Incineration," by **Darwin W. Townsend,** Engineer, Milwaukee Sewerage Commission, Milwaukee, Wis.

Mr. Townsend reported on progress with incineration of grit and all screenings at the Milwaukee plant. From their observations he believed that predictions could be made that in the future sewage sludges would also be incinerated satisfactorily and economically.

"Comparison of Various Methods of Aerating Sewage" was discussed by **Prof. H. E. Babbitt,** University of Illinois, Urbana, Ill.

Prof. Babbitt, as the result of experiments, said that the mechanical means of sewage aeration were less costly and simpler than the diffusion schemes with the considerable equipment required. He discussed and compared the various available aeration methods now in use.

Settling and Chlorination Relieves Overloaded Filters

"Overloaded Sprinkling Filters Relieved by Additional Sedimentation and Chlorination of Excess Flows," by **A. L. Tholin,** Consulting Engineer, Downers Grove, Ill.

Something had to be done to rectify a condition of stream pollution and to relieve the overloaded sprinkling filter plant at Downers Grove, Ill. Mr. Tholin conceived the idea of adding sedimentation capacity and sending to the filters the maximum load that could be safely applied in the nature of settled sewage.

The remaining settled sewage had been bypassed and chlorine applied to reduce its oxygen demand and to eliminate unsightly slime deposits and fungoid growths in the stream below. The results to date had proved that the process had been effective for the purpose intended and the scheme bids fair to prove an economical means of solving the problem at hand.

Dedication of the New Rockford Sewage Plant

G. J. Boehland, President of the Illinois Association of Sanitary Districts, presided at the dedication of the new Rockford Sewage Treatment Plant designed by Pearse, Greeley and Hansen of Chicago. Mr. Greeley of that firm briefly described the Rockford sewerage system and the plant, which consists of pumping station, grit removal equipment, primary settling tanks, sludge digestion and sludge storage tanks, and drying beds. (See Picture.) The plant is removing 86 per cent of the settleable solids and cost $422,000. Two intercepting sewers cost $2,200,000.

The principle address of dedication was made by Judge F. E. Carpenter, a lifelong citizen of Rockford. Others speaking were L. F. Warrick, H. F. Ferguson and B. H. Garrett, Attorney for the Rockford Project.

After dedication the members of the two Associations inspected the plant, which has been in operation since February 1, 1932.

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GLASS WATER PIPE.—The following interesting note is taken from a historical sketch of the water system of Schenectady, N. Y., included in the 1931 report of the Bureau of Water of that city:

In the early 40's Union College had a private water system; a hydraulic ram, fed by a spring located somewhere above Nott Terrace and north of Vale Cemetery, forced water through a glass pipe to the college. This glass pipe was about 1 in. in diameter and covered with a cement or mortar jacket about 2 in. thick. Pieces of this pipe are also to be found in the rooms of the Historical Society and in the Water Office.

INDUSTRIAL WATER SUPPLY ·AND TRADE WASTES·

WATER SUPPLY FOR THE PAPER INDUSTRY

By L. M. BOOTH

President,
Booth Chemical Co.,
Elizabeth, N. J.

IN a previous article under the above caption which appeared in the May issue of WATER WORKS AND SEWERAGE this subject was presented from a "fresh-water" supply standpoint. That which follows relates primarily to the conservation and reuse of water in paper and paper board mills.

We shall assume in this instance that the mill has an adequate supply of fresh water. If, on the other hand, the water demand is in excess of the existing capacity to pump or to purify, it is apparent that the consideration of more economical use of water is particularly pertinent. By adopting means for the effective utilization of water by recirculation, less fresh water is needed. Frequently it is feasible to adopt a highly efficient type of purification for a relatively small amount of make up water. On the other hand, the cost of adequate treatment of a large volume needed, as when reuse of the "white-water" is not practiced, would be prohibitive in many instances.

The leaders in the paper industry are already on record to the effect that economical use of water is of prime importance. The fact that the American Paper & Pulp Association retains the full time services of an engineer to promote economies in the use of water in paper mills is the best evidence that this important phase of paper manufacture requires more careful consideration than previously accorded it. In one of the reports of Mr. C. M. Baker, engineer in charge of this work for the American Paper & Pulp Association, he shows that, in fifty mills visited in 1930, those mills could save $1,000,000 annually by more complete utilization of the "white-water." The total saving which the industry may effect by adopting methods which have already been demonstrated as thoroughly successful is therefore several millions of dollars each year.

While the incentive to make increased profits is great, it is not the only reason why the loss of paper making materials, carried out in the so-called "white-water," to the sewer must shortly cease. The increasing pressure which is being exerted by governmental authorities to eliminate stream pollution, backed by growing public sentiment which is hostile to stream pollution, has already had a salutary effect on some cases. The adoption of each "closed-system" in a paper or board mill pays a handsome profit. The increasing number of successful applications of closed-systems is strengthening the hands of the public and of its representatives in pressing the campaign against stream pollution. While realizing that some pollution must enter the streams, under these circumstances the old contention that paper mills, particularly those which do not wash stock, must necessarily pollute the water courses which receive their drainage, does not carry the same weight as it did a few years ago.

In the past a number of court decisions have been rendered against stream polluting paper mills. Almost invariably these legal actions have been instituted because of the gross negligence on the part of the mill, or because of a mere belief on the part of the aggrieved party that the action of the industry was high handed. Often both of these causes have been responsible for resorting to court action.

In a number of states authorities, charged with the duty of conserving water supplies, have initiated educational campaigns of cooperation which promise advantageous results to all, whether concerned directly or indirectly. A clear picture of the damage to streams has been presented to the manufacturers. The legislators, representing farmers, sportsmen and others, have been shown that the interests of the industries are highly important and must always be taken into consideration when framing regulatory maesures. The result already has been beneficial to the industries to the extent that no state has recently passed any unduly drastic law relating to stream pollution. Tangible physical improvement of the streams is promised in the near future because of the installations of new equipment and the adoption of revised manufacturing procedure. This progress toward the common welfare is particularly gratifying to those who are directly responsible for the maintenance of public water works purification plants, especially in the highly industrialized sections of the country.

The problems of the pulp manufacturers, particularly sulphite and kraft pulp manufacturers, as well as those who wash old papers, rope, or rags for paper making are not yet solved. Further research and development with respect to utilization remains yet to be done in this field. The paper or board mills, however, using stock which does not have to be washed, are gradually adopting new methods and in a comparatively short time there need be no complaint because of stream pollution as a result of paper machine operation. Fortunately, the latter group, which does not have to wash the pulp, produce more than twice the tonnage of the former group. The total United States production of pulp, paper, and paperboard for 1931 was in excess of 9,000,000 tons.

The most attractive feature about this conservation development is that it is being accomplished without saddling any extra cost on the industry. Invariably increased profits follow the adoption of the new methods which keep the paper making materials out of the streams, and in consequence these are sold in the form of finished product.

During the past ten years, a great deal of thought has been given to the matter of providing adequate facilities

for the reuse of white water. At the beginning of this period settling tanks were most favorably considered where high efficiency in the separation of the solids from the white-water was sought. Even now sedimentation is generally practiced in handling clay-laden white waters.

For papers made without mineral filler it became apparent that unless coagulation is practiced, similar to water works procedure, comparatively large settling areas are needed. Largely because the paper makers of seven or eight years ago were not so familiar with chemical procedure as applied to white water treatment at present, the number of white water settling tanks then being installed in paper mills from year to year, began to decrease. The next general tendency was to install high vacuum saveall filters in the effort to obtain a relatively clear white water for reuse.

Although a few mills began the use of chlorine as a white water disinfectant earlier, the present movement, looking toward the resuse of white-water and the complete elimination of slime from paper mills, did not make much headway until 1928. Since then hundreds of paper machines have been kept free from slime by the use of chlorine or chloramine.

Along with better understanding of the basic principles involved has come the realization that the greater measure of dependence is to be placed on chemical treatment of white-water. Consequently the paper maker is now depending, only to a minor degree, on the more elaborate types of mechanical saveall equipment such as he had favored a few years ago and white-water is returned to the system direct.

While there are notable exceptions to the above statements, with regard to the general trend in the handling of white water, there is no doubt but that the chemical treatment of white-water has become recognized to be of prime importance and that mechanical stock saving equipment—whether tanks or screen savealls—is of secondary importance. The fact that many paper machines are showered with white-water which has received no mechanical treatment and operate successfully, providing suitable chemical treatment is applied, is ample evidence that too much emphasis has been placed on high efficiency mechanical saveall equipment.

When inaugurating any program involving the use of white-water, due consideration must be given to the elimination of slime and other possible decomposition products. The state of the art at this time is such that it is no longer necessary, when closing a white-water system, to conjecture whether or not slime will be formed. This can be definitely foretold as a result of a survey which takes chemical, bacteriological, and temperature conditions into consideration.

If the stock of the fresh make-up water are of such character that it is definitely known that slime will form, due consideration should be given to providing a remedy at the outset. At this point the bacteriologist will be able to help by indicating, as a result of his tests, just what chemical treatment is needed in order that slime shall not form. Although treatment applied for the prevention of slime and decomposition is now fairly well recognized as necessary, additional compensating chemical treatment has been found to be justified in order to maintain optimum paper making conditions.

Most paper making operations are now carried out with due regard to pH values and other determining factors. Efficient chemical control in paper making can be just as readily maintained with closed system operation as when the water used as a vehicle in the process

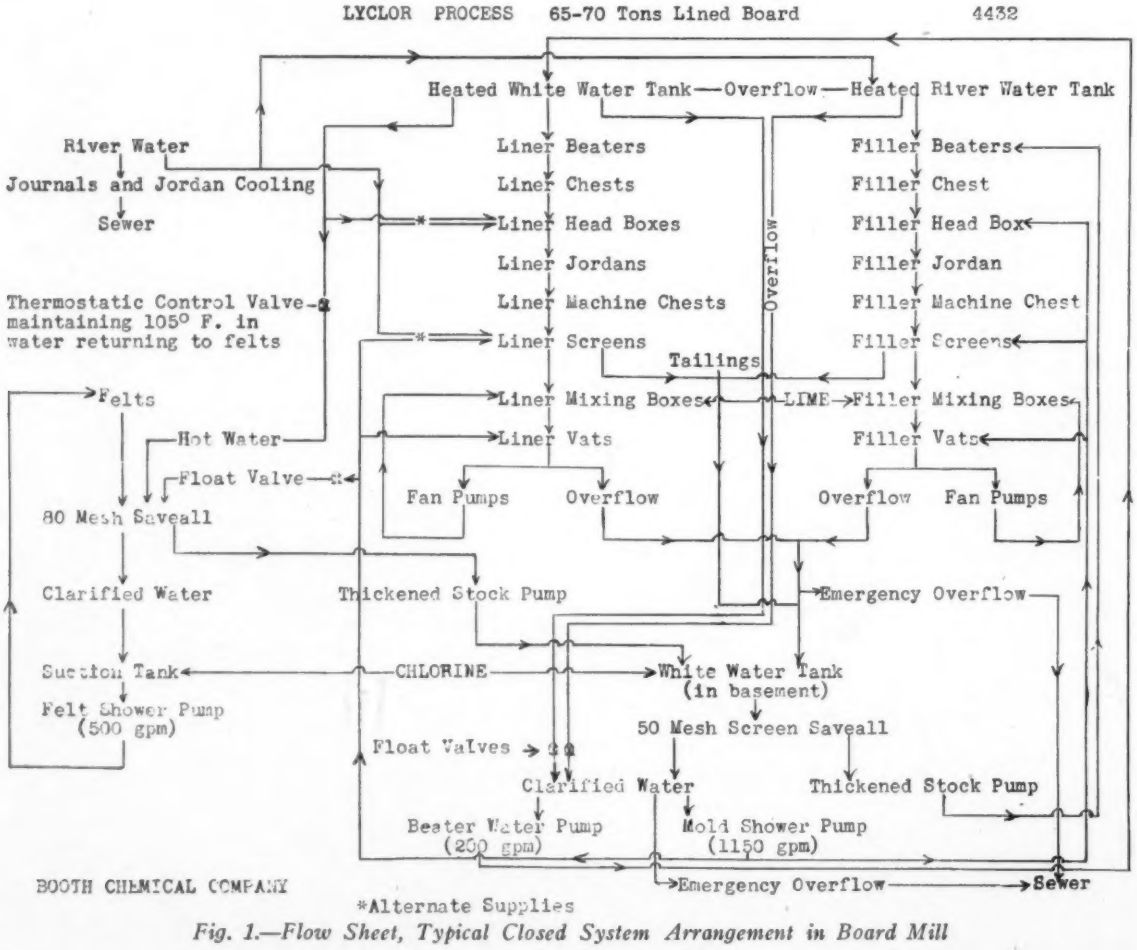

Fig. 1.—Flow Sheet, Typical Closed System Arrangement in Board Mill

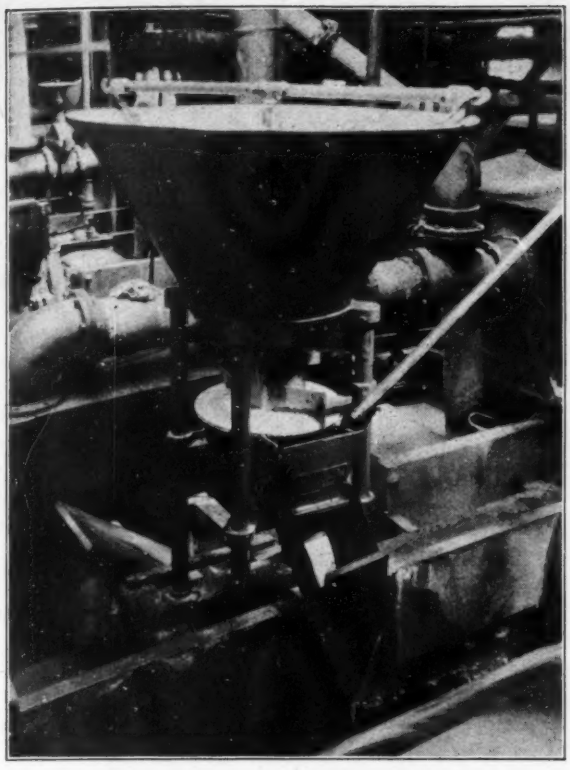

Fig. 2.—Booth Type Chemical Feeder, Used in Water Works and Industrial Plants, Including Paper and Board Mills; Manufactured by Wallace & Tiernan Co., Newark, N. J.

is being constantly renewed. One of the outstanding benefits of closed system operation is that uniform temperature can be maintained at all seasons. Since for most of the tonnage of paper and board, higher paper making temperatures can be employed advantageously, the value of the heat which is retained is reflected in the form of an attractive saving when the water is recirculated through the closed system.

Figure 1 is a flow sheet of a typical closed system as operated in connection with a paperboard machine. In this system the mechanical screen saveall equipment is simple and inexpensive. The chemical treatment keeps the system free from slime and affords better control over sheet formation and finish of paperboard.

Figure 2 illustrates a type of dry feeder which is familiar equipment for the application of chemicals in public water works filtration plants. In paper mills these feeders apply various chemicals to the stock as delivered to the paper machines for the purpose of controlling the various phases of sheet formation, sizing, etc. One mill uses eleven feeders at various points on the several machines.

The advantages realized for the closed system as compared with the former open system of operation are as follows:

1. Saving of fresh water.
2. Saving of stock.
3. Conservation of heat.
4. Better control of operation.
5. Elimination of slime.
6. Improvement of product.
7. Increased production.
8. Lengthened felt life.
9. Reduction of steam pollution to minimum to meet requirements of state authorities.

A more widespread understanding among paper makers concerning the fundamental principles of the most advanced methods of treating white-water is needed.

DINNER IN HONOR OF NOTED ENGLISH ENGINEER

GEORGE W. FULLER gave a dinner June 9th at the Engineers' Club, New York, to honor an eminent British sanitarian and engineer and a past president of the British Institute of Engineers—John D. Watson of Westminster, England.

The host had arranged a program of 5-minute talks by several of the twenty-six invited guests in order that Mr. Watson might be informed concerning developments in sanitation in America—particularly the progress made since Mr. Watson's visit to the United States in 1912 when he served in a consulting capacity to the Metropolitan Sewerage Commission of New York.

Sanitary Engineering in America

M. N. Baker reveiwed early developments in sanitation in America. He was followed by Dr. Geo. A. Soper, formerly president of the New York Metropolitan Sewerage Commission, who said that Mr. Watson had been retained as the highest authority, to review the reports of that commission in 1914.

L. C. L. Smith, Engineer Commissioner of the New York Department of Sanitation, told of current activities under way in his department and reviewed the developments. He said that the new Wards' Island sewage treatment works would be ready for operation by January 1935 and that four other projects, to cost between $600,000 and $1,000,000 each, were being advocated as being immediately necessary. Contracts for projects totaling $2,500,000 would be made shortly, but $500,000 only would be available this year. Other projects than that for Wards' Island would make use of primary treatment and chlorination for the present. This because a greater volume of sewage could be thus treated without delay, from the funds available now or to become so in the next year or two.

J. R. Van Duyne, Chief Engineer, Passaic Valley Sewerage Commission, reviewed the developments of the Passaic project wherein 160 m.g.d. sewage is given sedimentation and the sludge barged to sea. The project cost $21,000,000, required 12 years for completion, had been in operation 8 years and cost $800,000 per year to operate. The system, embracing 42 miles of sewers 4 ft. to 12 ft. in diameter, serves 22 municipalities, handles all trade wastes and domestic sewage from more than one million people.

T. J. Wasser, chairman of the Hackensack Valley Sewerage Commission, spoke of the developments to date and the methods of financing proposed for the Hackensack Valley project wherein 58 municipalities would be served by two large treatment works.

Wm. R. Copeland, Sanitary Engineer of the State Water Commission of Connecticut, spoke on the matter of stream pollution correction in Connecticut, stressing the point that by law the commission "Must show means and processes for purification" before the treatment of any particular industrial waste could be ordered and enforced by it. Under the unique circumstances, he said, progress had not been as rapid as otherwise.

H. P. Croft, Chief Engineer of the New Jersey Department of Health, referred to progress made by state health departments along sanitary engineering lines. He called attention to the existence of state laws requiring that operators of water purification plants and sewage treatment works be qualified men, licensed by the state department of health. Recent court decisions had strengthened the hand of the department in respect to the

license law and to pollution abatement. He said that it was becoming prevalent now to approve of sewerage systems only where adequate treatment of the sewerage was assured.

C. A. Emerson, Jr., chairman of the Federation of Sewage Works Associations, reviewed the rapid strides made by that association during its short life of 4 years. He told Mr. Watson that the federation was composed of 16 individual sewage works associations having a total of 1,500 members and that it had been patterned to include most of the best features of the Association of Sanitary Engineers and the Sewage Works Managers Association of England.

H. deB. Parsons, general chairman of the Professional Engineers Committee on Unemployment, recounted what had been accomplished in the way of relief for unemployed engineers. He stressed the need of starting a benevolent reserve fund, in each of the four major engineering societies which would be promptly available for relief work in the future. He made reference to such a fund having been started some years ago in British Engineering Societies.

Geo. T. Seabury, secretary of the American Society of Civil Engineers, spoke on the progress made in America concerning the legal licensing of professional engineers and the steps being taken in an endeavor to bring about the "Certification of Engineers." He said that more than half the states now enforce engineering licensing laws which had proven very helpful, but that the scheme of "Certification" would be a more advanced step toward raising the general plane of the engineering profession.

Mr. Fuller then introduced Mr. Watson as the "Dean of Sanitary Engineering"—he having entered the field as one of the pioneers and having gone forward to the position of chief engineer of the Birmingham, Tame & Rea Drainage District, more than 30 years ago. At the present, Mr. Watson's firm, Dodd and Watson of Westminster, England, are serving as consultants on the extensive $30,000,000 Middlesex County drainage project which embraces 22 towns and villages adjacent to London.

Mr. Watson Responds

Mr. Watson in response complimented us in America on the rapid and fearless progress made in sewerage and sewage treatment. He touched on the developments in sewerage during his lifetime and remembered pleasantly his last visit to America in 1912 and his contact here with American engineers. He said that he had come this time for a rest following an illness, but planned to visit several of the important American treatment works before returning.

He emphasized the point that the basic law of engineering required that the engineer suggest methods and processes of sewage disposal consistent with funds available. He referred to the proper and full use of the dilution available in streams rather than recommendation of needlessly extensive works involving costly operation where such is non essential to the solution of the problem at hand. Such an "admonition" he wished to leave with all who had to deal with sewage treatment and disposal.

In his work he had always advocated centralized treatment works for sewerage districts and the establishment of river boards as the administrative body to control pollution and stipulate the degree of treatment to be given trade wastes and domestic sewages entering that particular stream. In this direction the establishment of the Middlesex District adjacent to London had been the most recent advocated by him and had been brought about as the result of the successful workings in the Birmingham, Tame, and Rea District and others that followed. In the Middlesex district nine major contracts had been let and about £6,250,000 (upwards of $30,000,000) was the estimated cost of the project. The new project would entail treatment plants to serve 2,000,000 people with a dry weather flow of 80,000,000 gallons per day (40 gal./capita) but would handle up to 240 gal./capita storm water and give it a partial treatment. In as much as about one half of the £5,000,000 estimated expenditure during the next 4 years represented a grant for unemployment relief it was essential that the work be pushed forward at a prescribed rate if the grant was to be made full use of.

Reverting to the matter of "Sentiment vs. Sewerage" Mr. Watson agreed that good laboratories and efficient management at sewage treatment works were highly desirable but that sentiment should not cloud common sense in matters pertaining to the problem at hand and that it was incumbent on the engineers to see that public funds were not "sentimentally" wasted in sewage disposal practice.

In addition to the speakers, the following enjoyed the hospitality of the host and the pleasure of meeting so distinguished a visitor as John D. Watson:

John T. Calvert, London, England; H. Burdett Cleveland, Cons. Engr., New York City; F. G. Cunningham, Fuller & McClintock, New York City; L. H. Enslow, Editor, Water Works & Sewerage, New York City; L. M. Fisher, Sanitary Engineer, U. S. Public Health Service, New York City; A. P. Folwell, Editor, Public Works, New York City; R. H. Gould, Engineer, Department of Sanitation, New York City; A. R. Holbrook, Fuller & McClintock, New York City; T. R. Kendall, Engineering Editor, The American City, New York City; Malcolm Pirnie, Consulting Engineer, New York City; W. R. Smith, Secretary, Hackensack Valley Sewerage Commission, Tenafly, N. J., and W. W. Young, Consulting Engineer, Westchester County Sanitary Sewer Comm., White Plains, N. Y.

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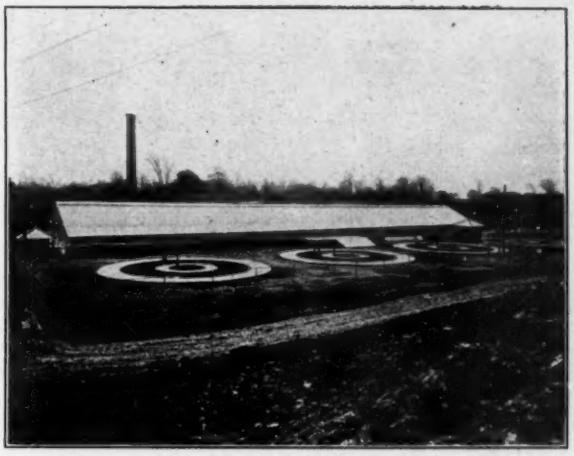
Cost of Sewage Treatment at Worcester, Mass.

The cost of sewage treatment at Worcester, Mass., for the year ending Nov. 30, 1931, is summarized as follows in the annual report of John H. Brooks, Jr., superintendent of sewers:

	Total	Per Million Gallons
Screen	$ 3,628.03	$0.50
Grit Chamber	1,728.12	0.24
Imhoff Tanks	10,812.85	1.51
Trickling Filters	7,877.69	1.10
Secondary Tanks	5,247.91	0.73
Sludge Disposal	23,228.25*	3.24
Laboratory	6,307.19	.88
Total	$58,830.04	$8.20

*Includes $8,005.76 expended for construction of a new pumping station and pipe line.

The sewage treatment plant was placed in operation on June 25, 1925. The approximate cost was $3,800,000. The plant consists of grit chambers, screens, Imhoff tanks, dosing tanks, trickling filters, secondary settling tanks and sludge drying beds.



Sewage Treatment Works at Tonawanda, N. Y. No. 2 Plant.

MEETING OF THE NEW YORK STATE SEWAGE WORKS ASSOCIATION

THE Spring meeting of the New York State Sewage Works Association was held June 10th and 11th at the Hotel Statler in Buffalo, N. Y. Considering the location of Buffalo in the extreme western part of the state the registration of 137 members and guests passed expectations and the exhibits by 27 manufacturers were both attractive and instructive. Proof of interest was the difficulty experienced in getting the members from the exhibit rooms into the meetings.

Prof. Earle B. Phelps, Columbia University; President New York State Sewage Works Association.

A. S. Bedell, Secretary, New York State Sewage Works Association

At luncheon the first day, W. A. Rathman, Commissioner of Public Works, Buffalo, delivered the welcoming address.

At the business session Prof. C. L. Walker of Cornell University presented the report of the Committee on Sewage Plant Operators Short School held at Cornell University April 4-9, 1932 which had been limited to 25 registrants. Professor Earl B. Phelps, President of the association, announced that the executive committee had voted to hold the third Short School at Cornell University probably in April of next year.

The annual banquet was held and the local committee are to be commended on the high class of entertainment provided. Dancing followed.

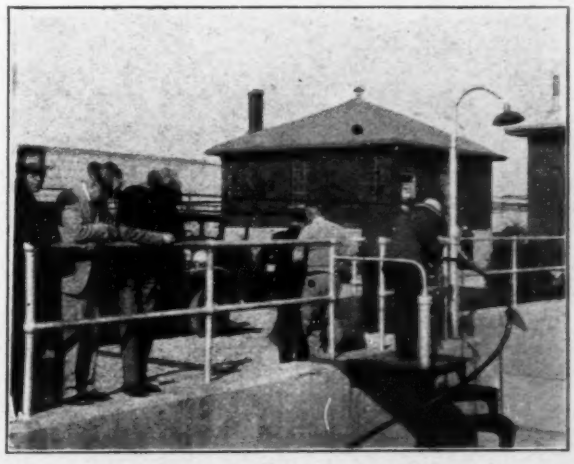
On the afternoon of June 11th a large number visited the sewage treatment works in the vicinity of Buffalo, including Tonawanda (District No. 2), Cheektowaga (District No. 3), Lackawanna, Blasdell, Woodlawn and Dunkirk. The two last named are modern plants in every respect including beautification of grounds and excellent operation. To this writer the trip was doubly enjoyable in that such marked improvement in operation and maintenance of plants and grounds was in evidence over the conditions noted at three of the older plants during the visits made to them only a year or two previously. It does not seem at all unlikely that the establishment of a district engineer's office of the state health department at Buffalo has been responsible in a large measure for the improvements noted. In charge of this office is Engineer Allen, formerly health officer at Coral Gables, Fla.

Prior to the Buffalo meeting many of those attending made a tour of visits to Canadian sewage works in the vicinity of Toronto and Hamilton. The entertainment and sight seeing tours provided for the ladies was a feature of the Buffalo meeting. The fall meeting will be held at Saranac Lake sometime in October.

Papers and Discussion

The most interesting paper presented was that by **A. F. Dappert,** Sanitary Engineer, State Department of Health in which was reported the studies made of the **"Travel of Pollution Underground"** from the seepage beds serving as disposal grounds for the effluent from the sewage treatment works of Rockville Center, L. I. The effluent eventually reaches a small stream, via underground travel.

Mr. Dappert recounted the findings of the U. S. Public Health Service studies of 1923 made of pollution travel through sandy soil formation as reported in Public Health Bulletin No. 147, issued in 1927. In these it had been proven that without outside



A Group Inspecting the New Dunkirk, N. Y. Sewage Treatment Plant [Bar Screens and Dorr Detritor in the Pit] F. K. Wing, Designing Engineer

influence pollution travelled only in the direction of ground water flow and that the band of pollution did not flare or spread appreciably wider than the length of trench into which the polluting material had been "planted." The rise and fall of ground water level had played an important part in the speed of travel of the pollution to adjacent test wells.

In order to study the underground course of the sewage plant effluent at Rockville Center, L. I., a series of 42 test wells had been put down and frequent samples drawn from these disclosed the extent

John Nelson, Superintendent Sewage, Woodlawn, N. Y.

A. Allen, Engineer State Department of Health, Buffalo, N. Y.

of underground pollution, the speed of travel, and the bacterial and chemical changes taking place along the 1,500 ft. distance of travel from the percolation beds to a creek fed by the sewage effluent "springs." The width of the band of pollution had been shown to be roughly 100 ft. wide near the beds and narrowed down to a 50 ft. width at a point near the creek (1,500 ft. distant). The activated sludge plant effluent had contained 1,000 b. coli per c c and but 0.04 parts of nitrate nitrogen. The oxygen consumed value had been 10 p.p.m. and organic nitrogen 7.14 p.p.m. with 12.5 p.p.m. nitrogen as free ammonia and a chloride content of 35 p.p.m. Samples from the wells nearest the creek showed absence of b. coli and very low 37° counts. The nitrate nitrogen had increased to 10 p.p.m., oxygen consumed decreased to 1.8 p.p.m., organic nitrogen to 1.4 p.p.m. and ammonical nitrogen to 6.0 p.p.m. The chloride content had remained unchanged at 35 p.p.m. B. coli had been removed within the first 400 ft. of underground travel through the sandy formation. As a result of these studies they had concluded that no deleterious pollution reaches the creek and that the natural purification of the effluent had been marked. The high nitrate content had, however, been responsible for vigorous algae growth in the stream.

J. S. Kneal, Superintendent of the Rockville Center Works in discussion said that complaints as to the plant having caused a nuisance and damage to the stream he believed largely imaginary. The plant had functioned without depreciation of nearby property value. He thought that perhaps the creek would be in just as good or better condition if the underground percolation had been left out and less nitrates thus contributed to the stream. Riparian owners had entered suit but he did not believe it could be proven that Rockville Center was harmfully polluting Parsonage Creek. To control odors the plant was being operated as carefully as could be and prechlorination of the sewage at the distant pump station had been effective in minimizing odors.

Professor Phelps, said that the Public Health Service studies had revealed the fact that the most important pollution of underground water occured in the top water or "fringe water" and that well casings properly installed would prevent that from entering the well.

A paper prepared by **Clyde Potts,** Consulting Engineer of New York City on **"The Design and Operation of Sewage Settling Tanks"** was presented by **Chester G. Wigley,** Consulting Engineer of Atlantic City, N. J.

Mr. Potts reviewed the progress in sewage treatment and the evolution of the Travis type of tank from the earlier Cameron septic tank and the Imhoff tank from the Travis tank which also had a separate sludge compartment and the central slot. The next important development had been the process of separate sludge digestion. Mr. Potts said that it appeared probable that engineers would be returning to the chemical precipitation process of sewage treatment in an improved manner and with modern equipment. Digestion would be avoided and vacuum filtration would be employed to dewater sludge which could then be incinerated or disposed of as wet cake on the land.

Mr. Wigley injected a reference to the handling of sewage solids at Atlantic City where the "green" solids are partially dried on sand beds and transferred to open side sheds where natural moulds converted the odorous material to a satisfactory fertilizer in 36 to 48 hours, at 86° F.

John F. Skinner, of Rochester, N. Y., rose in defense of the Imhoff tank but stated that adequate sludge capacity was the essential part of "well behaving" Imhoff tanks. Those at Rochester with but a 45-minute detention period continued to produce satisfactory effluents and sludges which could be handled on sand beds with but 0.33 sq. ft. of area per capita.

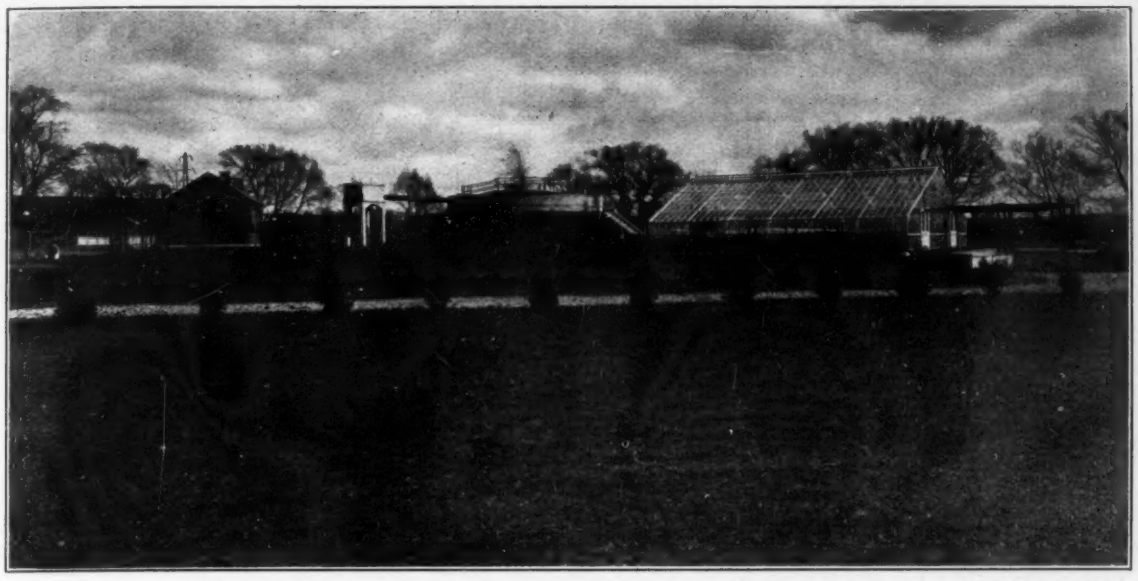
Glen D. Holmes, of Syracuse, N. Y. said that the small Imhoff plants at Syracuse, where the sludge

C. G. Wigley, Consulting Engineer, Atlantic City, N. J.

Glen D. Holmes, Chief Engineer, Sewer Board, Syracuse, N. Y.

is transferred for completion of digestion in separate tanks, had been performing satisfactorily.

In reply to a question Mr. Wigley described the method of fertilizer production via the mould route at Atlantic City somewhat in detail. These growths would destroy the sewage solids odor within 1 to 2 hours and they also produced rapid drying of undigested sludges. At 80 per cent moisture the sludge was removed from the sand beds to the drying and "moulding" sheds and was ground 48 hours



Sewage Treatment Works, Woodlawn Sewer District Plant No. 1 Near Buffalo, N. Y. Sprinkling Filters Behind Imhoff Tanks and Sludge Bed Enclosure; Geo. C. Diehl, Engineers

later, when it still had a 30 per cent moisture content, and was sold in that condition as fertilizer. Thorough mould treatment would preclude odor troubles from the applied sludge on lawns, etc.

L. H. Enslow commented on the matter of improved or modernized chemical precipitation of sewage. He thought it would probably give rebirth to that once frowned upon process because of the then inadequate means of handling the relatively large quantities of sludge produced and lack of understanding of coagulation.

C. C. Agar, Engineer State Department of Health, remarked that chemical precipitation might be used also in conjunction with some form of secondary treatment and possibly with economy and a more uniform plant performance resulting.

Experiences in the **"Remodelling of an Old Sewage Works at Lancaster, N. Y."** were presented by **H. J. Huber,** Superintendent of Public Works at Lancaster.

Mr. Huber, with a $10,000 allotment of state emergency relief funds had recently overhauled and repaired leaking sewers and a badly neglected sewage treatment plant. The contact beds had been cleaned out, repaired and new stone put in. Flows in excess of the contact bed capacity could at least be settled and arrangements had been made for chlorination of the settled sewage when that was necessary. As a result of the improvements chlorine requirement for the effluent had been reduced by approximately 33 per cent.

Experience with making sewer joints had shown that cement joints were satisfactory. To remove roots from sewers the sectional rods with screwed joints had proven superior to others. He felt that state or governmental aid made available to municipalities should result in a rapid improvement of sewerage systems and other public works as had been the case at Lancaster.

A. Allen, Engineer, State Department of Health had followed the Lancaster work closely and said that it was remarkable to him what Mr. Huber had accomplished. He recommended that other municipalities avail themselves of the same opportunity to secure financial assistance and improved works. By such revamping, savings in operating costs for labor, pumping and chemicals would yield a handsome return on the investment.

John F. Skinner of Rochester said that they preferred the poured asphalt or bituminous joints in sewer work to the cement joint. It had prevented root troubles more effectively. Mr. Huber, replied that only premoulded joint strips had been tried and to these he preferred the cement.

C. G. Wigley, said that the Atlantic City Sewerage Company prepared a joint compound from melted tar in a wheelbarrow bed to which cement is added until a putty like mass results. Ropes are hand rolled from this and squeezed into the bell at the joints. After 30 years' standing these joints had been found O. K. The mixture consisted of about 2 parts cement to 1 of tar, by volume.

Developments in Mechanical Sludge Handling Equipment

E. B. Besselievre, Engineer, The Dorr Company, New York, discussed the value of **"Mechanical Equipment for Solids Removal from Settling Tanks."**

Mr. Besselievre stated that the use of mechanically cleaned sewage tanks had grown from one unit in 1920 to more than 400 in 1932. This development had resulted because of the difficulties with Imhoff and septic tanks. Some clarifiers have operated 4 to 5 years without dewatering. Objections to use of mechanical equipment and the power cost had been more than counterbalanced by the advantages gained. The employment of higher grade plant operators and improved operation had resulted. With improved equipment and odorless operation it was no longer requisite that the treatment works be a great distance away and served by expensive outfall sewers. Plants with clarifier mechanisms for capacity exceeding 1 m.g.d flows can be built for less money than the old style tanks requiring deep excavation. For plants with flows up to 50 m.g.d. not more than two settling units will be required. The 180 m.g.d. Wards' Island Works will use but 8 clarifier units and the Northside Chicago Works has 200 m.g.d. flow and but 8 settling tanks. With the clarifier 2 hours retention will prove adequate as compared with a 4-hour period for the older type of tank. The

thickening action of the plows on the mechanism reduced sludge volume and thereby pumping costs and volume of digestor liquor displacement were reduced.

M. B. Tark, Engineer, The Link Belt Company, was called upon by the chair to discuss Mr. Besselievre's paper. He questioned the claims made for the sludge scrapers as moisture reducers i. e. increasing the sludge density and decreasing its volume. He thought depth of tank more important in that direction than mechanical treatment. He questioned

John T. Mockler, City Engineer, Buffalo, N. Y.

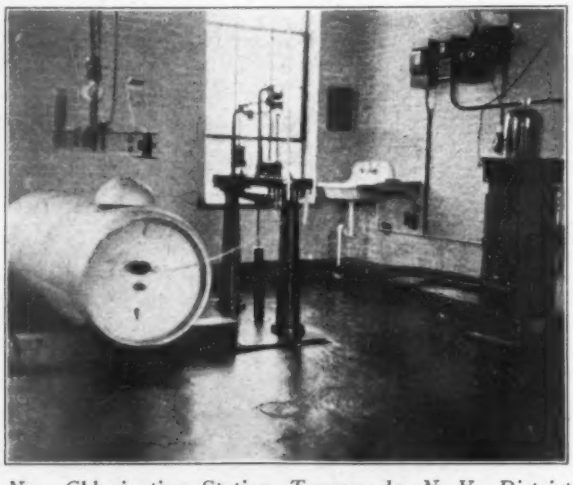
N. L. Nussbaumer, Consulting Engineer, Buffalo, N. Y.

the inference that mechanical equipment in itself caused a reduction of odors around sewage works.

M. C. Fleming, of the Hardinge Company, was requested for comments also. He stressed the importance of providing prompt and effective transfer of fresh solids from the collecting sumps of mechanically cleaned tanks and thought that effective skimming was also important. He felt that it was not sufficiently appreciated that mechanical equipment could be installed in already existing tanks.

L. H. Enslow, pointed out sources of hydrogen sulphite and odor production and the causes of less satisfactory effluents from Imhoff tanks that were obviated in mechanically cleaned plain settling units. At the same time less chlorine would be required in conjunction with the latter as compared to Imhoff tanks and inadequately cleaned plain settling tanks.

Morris Cohn of Schenectady presented his experiences when hosing down gas vents on Imhoff tanks which he had concluded should not be done except when absolutely necessary. The practice produced inferior effluent, more odors and higher chlorine requirement. **Professor Phelps** said that he had had the same experience at Greenwich, Conn.



New Chlorinating Station, Tonawanda, N. Y., District No. 2 Sewage Treatment Works

C. C. Agar, referred to the advantage of designing or remodelling Imhoff tanks to provide scum withdrawal from vents to drying beds or to separate digestion tanks for disposal. He had found hosing of vents to be the next most satisfactory means of keeping abreast of the scum problem, but appreciated that it was somewhat deleterious in other directions.

"The Care and Operation of Chlorination Equipment" was discussed and demonstrated on the floor by **K. A. Kiern,** Buffalo District Manager of Wallace and Tiernan Company.

Mr. Kiern correctly said that the service procured and the economy of chlorinator maintenance will be in direct proportion to the care given the equipment and the understanding of its functioning. He made definite recommendations to cover daily and weekly routine inspections and weekly cleaning. The vacuum type chorinator was used in the demonstration.

"The Significance of Laboratory Tests at Sewage Treatment Works" was presented by **C. C. Agar** of the New York State Health Department.

Mr. Agar stressed the value of keeping laboratory records and operation data for use in combating law suits and in evaluating plant performance and design. He defended the methylene blue stability test as being practical, simple, fairly dependable and of considerable value when applied to effluents. In determining the pH value of sludges the result would in many instances be affected by the method of handling the sludge. He had concluded that the dilution of sludge samples not to exceed 15 parts of distilled water to 1 part of sludge by volume to be the most

C. C. Agar, Engineer State Department Health, Albany, N. Y.

C. L. Howell, Engineer in Charge Sewerage, Buffalo, N. Y.

dependable and the simplest procedure. The Brom-Thymol Blue indicator is added to the diluted samples and has proven the most satisfactory for sludge. For solids determination in sludges he recommended the use of flat bottomed nickel dishes. In sampling practice when catch samples are taken it was thought best to make the collections during the period when the major daily flow is passing through the plant.

"Wild Flower Planting at Sewage Treatment Works"—was advocated by **Professor Earle B. Phelps** of Columbia University, New York as being a practical and inexpensive means of beautifying the grounds around sewage plants.

Professor Phelps said that it would be necessary to select the more hardy varieties of wild flowers and shrubs indigenous to the local climate and soil. He listed a large number of such plants including ferns, Pickrel Weed and Skunk Cabbage for wet spots. He mentioned the Horth Weed, Jerusalem Artichoke, Hawk Weed, Daisies, Shad Bush, Devils Paint Brush, Spikenard, Buttercups and Dandelions.

FILTRATION OF SEWAGE SLUDGE AT COLUMBUS,O.

By D. F. IRVIN

Engineer, Oliver United Filters, Inc., New York City

IN 1931 the City of Columbus, O., undertook the investigation of dewatering methods for the sewage sludge produced from their present Imhoff tank installation, and which was being dried in the customary manner on sand beds. R. A. Allton, Sewage Disposal Engineer for the city of Columbus carried out this work for which purpose a 3 ft. diameter by 2 ft. long Oliver filter test unit was supplied, as well as personal assistance by the staff of the Oliver United Filters, Inc. The purpose of this work was to collect information on mechanical sludge dewatering as a method comparable to existing sand beds.

These test runs were considered as paralleling similar work on digested sludge elsewhere, although not identical. Since filtration of Imhoff sludge has not been carried out elsewhere by mechanical filters, the work here described has certain features of general interest.

The Oliver filter test unit with accessory apparatus was of standard type for the work at that time, although later developments in sludge filtration elsewhere have resulted in modification somewhat of the filter design. This would not, however, affect adversely the results which were obtained in Columbus.

Fig. 2—Oliver Filter (3 Ft. Diameter). Typical Dewatered Sludge Sheet Leaving Filter

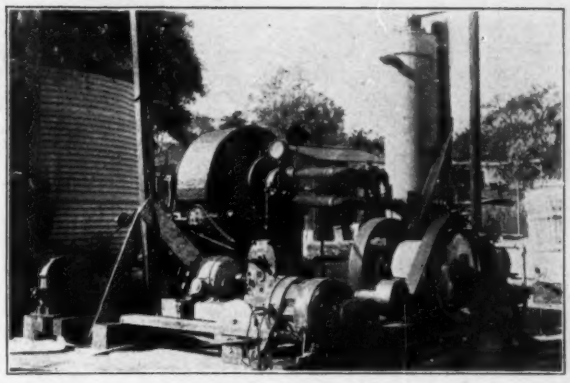


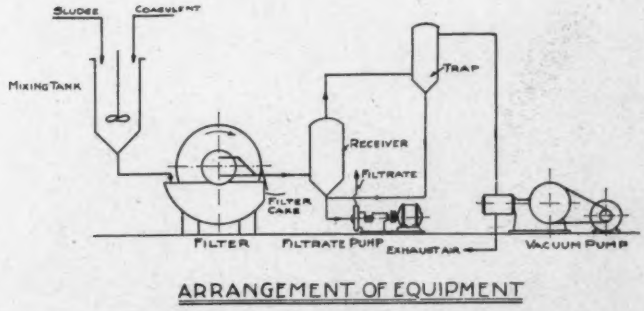
Fig. 1—Oliver Vacuum Filter (3 Ft. Diameter) Dewatering Digested Sewage Sludge

Test runs began about Nov. 1 and it is worth noting that the moisture in the filter cake then obtained was about the same as the accepted present practice. Considerable experimentation was done by varying numerous factors such as the speed of filter rotation, amount and kind of coagulants, concentration of the sludge fed to the filter, filter adjustments, such as depth of sludge in filter and submersion of the filter drum, and also the method of adding the coagulant. Beginning the work with a slow rotating speed, the filter was finally brought to its fastest speed compatible with proper formation of sludge-cake.

In general, the Imhoff sludge at Columbus proved readily filterable at higher speeds and with lower moisture than the rate established on activated sludge by similar methods. This means considerably larger amounts of sludge handled per unit of filtering area, and the moisture content of discharged cake at Columbus ranged between 70 per cent and 72 per cent—with occasional samples higher or lower. The sludge fed to the filter varied in density and the denser feed gave higher output of cake. Sludge of 6 per cent solids and higher was frequently available for use in the test.

Coagulants used were ferric chloride solution and occasionally some lime was added. Ferric chloride solution alone produces excellent coagulation and continuously good cake formation and quantities of the coagulant required were well within the economic limit.

Sludge filtration rates were established for a variety of conditions; some were unexpectedly high and all were several times higher than those for activated sludge. The rates established at Columbus should not be assumed to apply at all Imhoff plants without some checking, but it may be said that from 4 to 5 lbs. dry solids per square foot filter area per hour was a rate not difficult to maintain.



Arrangement of Equipment

As in other recent sludge dewatering operations using the Oliver filter, the drum of the filter at Columbus operated with a shallow immersion in the sludge being filtered. At first, dosage of the sludge was applied in batches but later continuous dosage was provided. A generally improved operation ensued with steady performance unobtainable from the previous scheme of batch dosing.

A temperature of 80° to 90° F. is expected in the sludge from the projected plant, which would be the temperature of the feed to the filters.

The general perspective offered by sludge filtration as judged from this series of trial runs at Columbus, is one of an attractive economy justifying continuous mechanical sludge filtration. All original requirements set for the test operation were fully met by the performance of filter equipment during the progress of the tests.

Recently a similar series of test runs with Oliver filter on digested sludge at Baltimore, Md., produced decidedly successful results and provides significant confirmation of the success obtained in Columbus.

Unusual "Clean Water" Intake Screens at City of Detroit

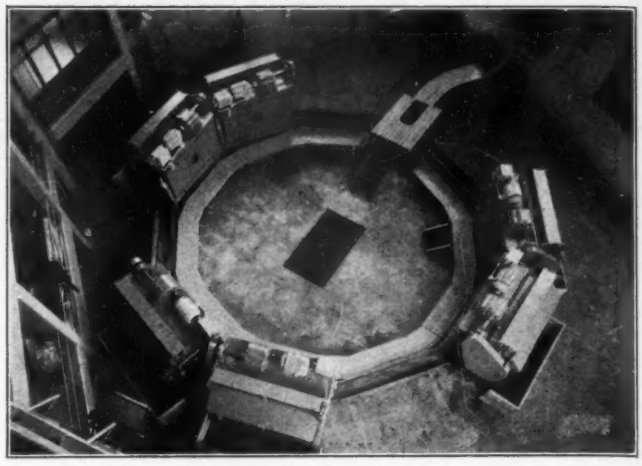
A unique water intake screen installation was recently completed at Detroit, as part of a large development program by the Department of Water Supply. The most unusual feature is the arrangement of the screens which are placed in a circular well, each one of the 10 units forming the side of a polygon. Raw water from the Detroit River is admitted to the cylindrical chamber surrounding the screen circle. After passing through the screens, it flows downward through a 14 ft. diameter opening in the center of the well, making a 90° turn and then flowing by gravity through a tunnel about 10 miles to the new Springwells Pumping Station.

This arrangement reduced the cost of screen chamber and housing, and provided an excellent effluent connection with the new tunnel. The screen house was built high enough to permit removal of the entire screen units by overhead cranes.

The initial installation consists of six vertical "Clean-Water" type screens, 8 ft. wide, with overlapping trays covered by No. 10 gauge copper wire cloth having ⅜ in. square openings. Guideways were provided for four future units, and stop logs inserted for the present. Refuse troughs are located on the inside of screens and drain in two directions to a single run-off pipe.

In an effort to prolong the life of screens to a maximum, several advanced features of design were incorporated in the wearing parts. One of the most important was the use of stainless steel pins, rollers and bushings in the chains to resist the destructive effect of alternate submerged and atmospheric corrosion.

Two of six 96 in. wide by 38 ft. Centers Water Screens.



View from Upper Gallery Screen House showing the Six Screens

The screens were designed and built under the direction of the engineers of the Detroit Department of Water Supply and were supplied and installed by the Link-Belt Company of Chicago.

Southern Illinois Water Works Conference

A southern Illinois conference on water purification was held at the State Normal University at Carbondale, Ill., May 27, 1932. There was a registered attendance of 93, representing 42 of the 79 standard purification plants of the state. It was primarily a meeting for superintendents and operators of purification plants to exchange ideas. It took the form of a general discussion; the principal topics were:

Coagulation, Mixing and Settling. Presided over by John R. Baylis, Chairman Illinois Section American Water Works Association.

Aeration, Tastes and Odors. Presided over by M. S. Sabin, Sanitary Engineer, State Department of Public Health.

Chlorination. Presided over by A. E. Gorman, Filtration Engineer, Chicago.

Softening and Iron Removal. Presided over by Charles Spaulding, chemist, Springfield.

Importance of Proper Treatment of Public Water Supplies as a Health Measure, by Harry F. Ferguson, Chief Engineer, State Department of Public Health.

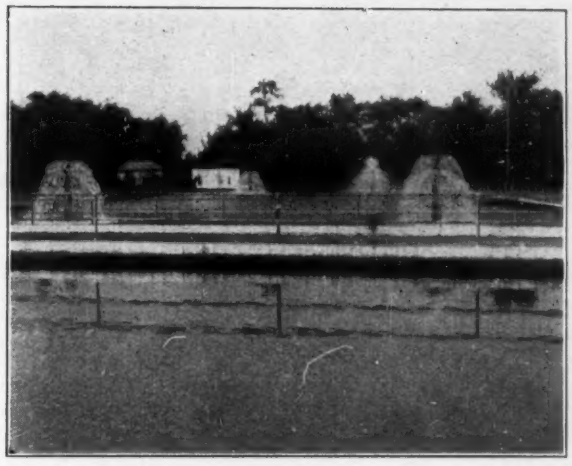
Water Supplies Around the World. An illustrated talk by H. E. Babbitt, Professor of Sanitary Engineering, University of Illinois.

Miscellaneous Topics and Question Box. Led by C. S. Gill, Superintendent of Waterworks, Carbondale.

The conference was so well attended and the interest shown so keen that it was decided to organize a Southern Illinois Water Works Division to hold meetings in centrally located cities of the Southern Illinois Section.

The officers elected were: President, C. S. Gill, Supt. Water Works, Carbondale; Chairman, Harry F. Ferguson, Chief Engineer State Department of Public Health, Springfield; Vice-Chairman, J. E. Carroll, Staunton; Secretary, O. H. Brown, chemist, East St. Louis and Interurban Water Company. An executive committee of the following members was appointed: M. M. Symons of Danville, Alvin Misker of Herrin, Harry F. Fuhrhop of Sparta, William Shoemaker, Cairo, and G. T. Vandaveer of Whitehall.

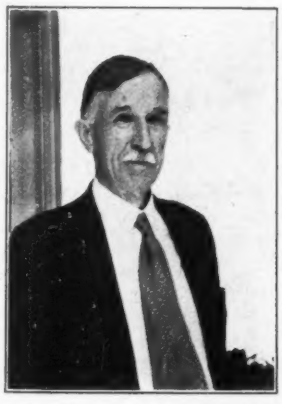
Aeration Basin, Atlantic City, N. J., Water Works.



MEETING OF THE 4 STATES SECTION, A. W. W. A.

THE Spring Meeting of the Four States Section of the American Water Works Association was held on June 7th and 8th at the Madison Hotel, Atlantic City, N. J. There was a registered attendance of 84 with probably 100 present at the meeting and the novel "Bavarian Saenger-Fest" which constituted the evening's entertainment.

Beckman C. Little, Secretary of the A. W. W. A., was a bit unkind to the Bavarians, "stealing the show" so to speak by his humorous and witty account of some of the "happenings" at the Memphis Convention of the A. W. W. A. and thereafter reporting also on the serious business transacted.



L. Van Gilder, 1931-1932 Chairman 4 States Section A. W. W. A.; Engineer and Superintendent Atlantic City Water Works.

H. T. Critchlow, Chairman-elect 1932-33 4 States Section A. W. W. A.; with New Jersey State Water Policy Commission.

The meetings on June 7th were presided over by Chairman L. Van Gilder, Engineer and Superintendent of the Atlantic City Water Department. On the second day the newly elected Chairman, H. T. Critchlow of the New Jersey State Water Policy Commission, shared the chair with S. T. Powell, Chemical Engineer of Baltimore, the new Vice-Chairman.

C. H. Becker, of R. D. Wood and Company, Philadelphia was re-elected Secretary and Treasurer. New Trustees elected to fill the expired terms of S. N. Van Trump and J. S. Strohmeyer were H. S. R. McCurdy, Chief Engineer, Philadelphia Suburban Water Company and W. Compton Wills, Engineer and Superintendent Wilmington (Delaware) Water Department.

Col. W. T. Chevalier, of Engineering News Record, addressed the meeting on the subject of the Water Works Betterment Program as sponsored by the A. W. W. A. during the Memphis Convention and explained the merits of the two major bills now in Congress that should produce an expansion of water works construction and betterments. A resolution was passed which endorsed the A. W. W. A. action at Memphis and voiced approval of the Wagner bill now before Congress, as providing a workable and sastisfactory means of attainment of the ends sought. A telegram to this effect was sent to the eight senators representing the states of Maryland, Pennsylvania, New Jersey and Delaware, urging their support of the Wagner bill.

On June 8th a large number of the members inspected the new well supply developments of the Atlantic City water supply and the pumping station, where exists the first installation of a DeLaval steam turbine and direct driven pump unit installed in the water works field.

Papers and Discussion

"The History of the Atlantic City Water Supply" was presented by Chairman **L. Van Gilder,** Sup't. and Engr., of the Atlantic City Water Department. He said that the city's supply was taken largely from 13 drilled wells, the deepest being 675 ft., seven being 200 ft. deep and five drawing from the 100 ft. depth. Their combined capacity was 20,000,000 gallons per day and several were free flowing when not in service.

Later an opportunity was given to inspect the system and the new wells recently constructed for the city by the Layne-New York Company, in which Johnson well screens of "Everdur" had been used. An interesting and novel "cut in" and "cut out" device has been developed locally to automatically throw in as many of the new wells as might be required to maintain a full reservoir at the pump sta-

Sheppard T. Powell, Vice Chairman 4 States Section A. W. W. A.; Consulting Chemical Engineer, Baltimore, Md.

Chas. A. Becker, Secretary-Treasurer 4 States Section A. W. W. A.; with R. D. Wood & Co.

One of the New Wells, Atlantic City Water Works. Layne-New York Installation with Johnson "Everdur" Screen

tion. Automatically operated chlorinators had been recently installed to take care of the fluctuations in flow.

"Under ground Water Conditions in the Atlantic City Region"—was discussed in a most interesting manner by **D. G. Thompson**, Senior Engineer, Water Resources Division of the U. S. Geological Survey, Washington, D. C. He said that incursions of salt water into some of the privately owned beach front wells was a possibility if the ground water level continued to drop as it has. The city's well field being several miles back from the ocean front was not in danger of salt contamination. The ocean front wells had been free flowing in 1893 but at present the pumping has dropped the water level to 60 or 70 ft. below ground surface. The fresh water is obtained at the 800 ft. sand level and originates from surface water entering these sands at a point near Kirkwood, N. J.

Advantages of Sanitary Districts

A paper on **"The Washington Suburban Sanitary District,"** was presented by **Harry R. Hall,** Deputy Chief Engineer of that District, with headquarters at Hyattesville, Md. Mr. Hall, reviewed the developments in the Washington Suburban Sanitary District from its conception in 1911 and since 1920 under the direction of Robert B. Morse, Chief Engineer. Twenty small municipalities and an area of 102 square miles with a population of 65,000 in the district, with a water consumption of 6 to 8 million gallons per day, were now being served. Methods of financing the project were disclosed as being a 7 cent tax per $100, on property for the entire district supplemented by front foot benefit charge on properties abutting the water lines and sewers, the greater part of construction costs being carried by the latter. These charges had been spread over a long term of years and used in paying interest and retiring bonds.

The commission constructs all water and sewer connections as far as the property line, making a flat charge of $42.50 for a ¾ in. service and 6 in. sewer connection. The system is 100 per cent metered and the commission owns the meters. The domestic water rate is 22 ct. per 1,000 gallons for the first 50,000 gallons used semi-annually, plus a $4.00 (annual) ready to serve charge on household services. The average total annual cost to the owner of a $6,000 assessed property abutting on water and sewer lines, had been $35.40. For an undeveloped lot it had been $14.53 and for property not accessible the cost had been but $4.20 per year. The water rates are fixed sufficiently high to pay the cost of construction and operation of the water and sewerage systems and treatment works.

During the 14 years of construction of water works and sewerage systems $10,000,000 has been spent and much remains yet to be done. The construction of the main water supply and sewerage treatment works will be undertaken during the next two or three years.

Geo. W. Fuller of New York, in discussion, complimented the author and commented upon the rapid progress attainable in securing water supply and sewers through the setting up of sanitary districts to embrace suburban areas and groups of small incorporated and unincorporated towns. He said that such cooperative action was more effective than any police power which a state health department might bring into play, and therefore health departments should encourage movements to establish sanitary districts such as the four now in operation in Maryland. He commented upon the feasibility and desirability of having sewerage costs included in the water rents. In other places, especially in Ohio, separate sewer rental had been established to pay the operating costs of the system but that it was possibly more practical to include such charges in the water cost. He further complimented the Washington Suburban Sanitary Commission on its method of financing and bookkeeping wherein all costs had been adequately segregated for review.

Abel Wolman, Chief Engineer, of the Maryland State Health Department complimented Mr. Morse and his able staff on the sound progress made and being proposed. He stressed the financial and engineering advantages gained by a grouping of small municipalities into a district. Sanitary districts had eliminated political boundaries which had so frequently caused dissention between governmental subdivisions. The outlying districts in the Washington Sanitary District had not complained of the 7 ct. tax and two counties had in effect guaranteed the financing of the project. The general property tax

The First Turbine Driven Pump Unit Installed by the De Laval Co. in a Water Works Is at Atlantic City, N. J. Single Stage Turbine 9000 R.P.M. Reduced to 900 R.P.M. at Pump; Delivery 10 M.G.D. Against 145 ft. Head. Pump Unit Consists of Two Single Stage Pumps Connected by "Pretzle" Arrangement in Series Installed in 1910 and Still Serviceable

had been used also in the financing of the Salisbury (Md.) District without quarrel. He referred to the four Maryland Sanitary Districts that have successfully collected charges for sewerage based on water consumed. The charge included in the water rate had been a most satisfactory scheme for painlessly paying the costs of sewerage and sewage treatment.

"The Effect of Salinity on the Value of Water Used for Industrial Purposes" was the title of a graphically illustrated paper presented by **Sheppard T. Powell,** Consulting Chemical Engineer, Baltimore, Md.

Mr. Powell, presented experiences during the 1929 and 1930 drought on the Delaware River below Philadelphia, when the salt content of the river water had increased markedly and to an extent which had caused difficulties in operation of Zeolite water softeners at industrial plants and in boiler operation. The total solids content had mounted sharply on flood tides during the low river flows. That had resulted in increased blow down of boilers to maintain the required 2,000 p.p.m. maximum solids content at heavy cost for heat losses. Charts were shown to illustrate how increased salt and solids content had been responsible for definite monetary losses due to frequent blow-downs, wasted heat and reduced efficiencies of Zeolite softeners. In addition, steam condenser leakage is increased by high chloride content and cooling systems suffered worse from corrosion.

The solution to the problem on the Delaware had been the installation of raw water storage, (in this instance steel tanks), and pumpage only during the periods of best quality of the river water for use during the entire 24 hours. This selective taking of the river water had repaid the industry handsomely by way of coagulating chemicals saved in the purification and through other operating savings such as reduced blow down. The necessity of increasing the Zeolite softener installation had been averted also.

Abel Wolman referred to the incursions of salt (sea water) up the Susquehanna River to the extent that it had made the Havre de Grace, Md., municipal supply undrinkable in 1930. The chloride content had increased from a normal of 5 p.p.m. to 1,000 p.p.m. By synchronized filtration and operations of the Conowingo power station on the river above, water of 200 p.p.m. chloride content was later produced at Havre de Grace. He also referred to the operations on the Sacramento River in California in an effort to reduce the salt nuisance in the industrial areas. Mr. Wolman thought that a salt content expressed as 200 parts of chlorine would usually cause complaint by domestic users.

Mr. Fuller remarked that a great deal would depend upon what the consumer had been accustomed to and that 300 p.p.m chloride at Little Rock, Ark., had not caused complaint.

W. T. Sherman, Chief Engineer, Vacuum Oil Company, discussed the damage to boiler tubes caused by high magnesium content when phosphates had been used in boiler water treatment. High solids content of the Delaware water had caused an increase of blow down to as much as 30 per cent of the total make up water and represented a considerable loss. He felt that some means of forecasting river conditions in advance would prove highly valuable to large industries.

"The Water Resources Commission of Maryland" by **Abel Wolman,** Chief Engineer, Maryland State Department of Health, Baltimore, Md.

Mr. Wolman reviewed the situation existing in Maryland in respect to the lack of effective control over the water resources of the State. This had been so forcibly brought to light as a result of the 1929-1930 drought that Marylanders had become "water conscious" and, as a result, Governor Ritchie had appointed the recently formed Water Resources Commission. The elements of quality and safety of water supply are being adequately controlled by the State Department of Health but the commission would undertake the broader policy of regulation, preservation and allocation of the water resources for best use. Measurement of flows and district grouping of water resources for most economical development and a check upon the structure placed upon streams would be the aims of the commission. The commission is now studying the practice in other sections of America and abroad with the idea of formulating a workable and desirable law. Other than the department of health control, there existed no state agency empowered to pass upon design of dams for water supply or power developments. With the history of dam failures before it the commission intends to give that matter its close attention.

(Ed. Note: Mr. Wolman has been made Chairman of the Water Resources Commission of Maryland, which consists of six members—Robert B. Morse,

Abel Wolman and George Fuller Stopped Their Stroll on the Board-Walk Just Long Enough to Get "Snapped" for Water Works and Sewerage

F. H. Dryden, Dr. Thos. W. Koon, Dr. E. B. Matthews, Richard Mommers and Philip B. Perlman.)

"Elimination of Tastes and Odors in Water Supplies," by **L. L. Jenne,** Sanitary Engineer, Bureau of Water Supply, Philadelphia, Pa.

Mr. Jenne reviewed the various tastes which appear in the Philadelphia water supply and commented on the improved quality of the Schuylkill River supply and the increasing trouble with Delaware River water.

The Schuylkill improvement had been due to state department of health activities plus the survey started by the city in 1923 and is being continued now with two men devoting most of their time to that problem. The Schuylkill water produced taste 6 per cent of the time and the Delaware about 30 per cent. Slow sand filters had always produced more palatable water than the rapid filters. They had used ammonia-chlorine treatment with some advantage gained but it had not reduced the "X" taste. Activated carbon will be tried on a plant size test after completing studies in the laboratory. They had not found that infusorial earth or Bentonite clay possessed much power of taste removal at Philadel-

phia. "Dead-end" tastes had been the most pronounced and disagreeable.

F. E. Stuart, Development and Sales Engineer, Industrial Sales Company, New York, discussed Mr. Jenne's paper and related the rapid strides made with the use of activated carbon now employed in 207 plants as a taste control measure. In reply to a question he said that comparing activated carbon with wood charcoal there would be two distinctions: first the adsorption power was many times increased by activation and less would be required; second, that activated carbon compared with ordinary carbon could be pictured by comparing the structure found

Frank Trumbre, Chief Engineer, Pumping Station, Atlantic City Water Works.

M. Brunstein, Chemist, Atlantic City Water Department.

in uncooked rice and puffed rice. That is to say, the activation process puffs up the carbon and markedly increases the effective surface area per pound of carbon.

Dr. Franz Schmelkes, of the Wallace and Tiernan Company Research Department, described the part played by ammonia in chlorination practice and explained many of the results noted when ammoniation is practiced. Reducing the oxidation potential of the chlorine by producing chloramine was the first consideration and thereby the chlorine was slower to attack taste producing products and likewise would not combine with so many products. In this way it remained in an active state longer and preferred the ammonia to most other bodies present. The total chlorine consumed was for that reason less and the important residual chlorine remained for long periods in the form of chloramines. For this reason it was especially well suited to hold down bacterial and algae growths in reservoirs and distribution systems. He had observed residuals lasting for 10 days whereas with chlorine alone 10 hours would be considered a long period.

In a recent survey it had been shown that the use of ammonia had prevented tastes in 90 per cent of the cases where true chlor-phenols had been responsible for tastes, had prevented 100 per cent of the aftergrowth troubles and 95 per cent of the true chlorinous taste troubles. Its use has been 80 per cent efficient in algae control but had been only 30 per cent efficient in taste prevention where decayed organic matter or algae had already imparted a taste to the raw water. It had been his opinion that activated carbon served best in the last named cases, perhaps best with prechlorination, and that ammoniation would serve in most instances where aftergrowths or tastes **actually produced** by chlorination was the problem.

Dr. Schmelkes said that he believed it highly probable that disinfection and bacterial death ensues as the direct result of forming a chloramine by the attack of chlorine on the amine cell fluid of the bacteria themselves. The ammonia added served to produce more chloramine which would evolve chlorine slowly but with certainty destroy the bacteria in contact with it.

The Question Box

As is usual, the "Question Box" was interesting and particularly so with one Abel Wolman in charge. Where answers to questions deposited in the box were not readily forthcoming, the chair used its prerogative and called on members qualified to answer.

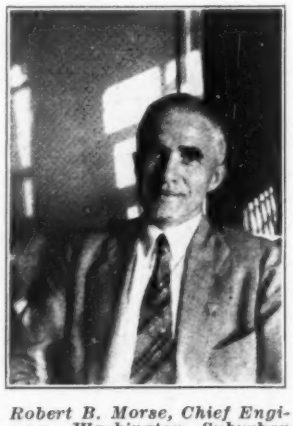
QUESTION: **"What is the prevailing practice in the matter of 'Shut Off' service for non-payment of water bills under present circumstances?"**

REPLIES: **Mr. S. Van Loan** of Philadelphia was called on for a statement and said that delinquent bills had totalled a sum of seven figures in the Philadelphia Water Department over the past two years but that fixed rules could not be applied under the circumstances. Decision as to continuance of the user were being decided in various ways, by organizations and sometimes by individuals.

Harry Huy gave past experiences with the Western New York Water Company, delinquents being given 15 days' notice. He had found 70 per cent of the delinquents to be chronic offenders but that would not be applicable at present.

J. J. Hillary of Boonton, N. J., said that water bills there were considered a lien against the property and no trouble had been experienced in making collections.

A member asked **Mr. Van Loan** if it was acceptable in Philadelphia to have the delinquents make a partial payment of some sort on over due bills? His reply was that it was not. **Harry Hall** of the Washington Suburban Sanitary District said that acceptance of partial payment was usually not considered good practice but rather than shut off a service they had been allowing the back bill to be paid off in 10 monthly payments. **C. A. Emerson** remarked that in some instances home owners had been given the



Robert B. Morse, Chief Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

Henry R. Hall, Deputy Chief Engineer, Washington Suburban Sanitary District, Hyattsville, Md.

privilege of partial payments on the installment plan where others had not.

QUESTION: **"Are 'shut off' men allowed to collect overdue bills?"**

REPLY: The consensus of opinion was that this should not be allowed and no one knew of where it had been practiced.

QUESTION: **"How often are large meters tested?"**

REPLIES: **Mr. Strothmeyer** of Baltimore said that meters were tested upon receipt and must show between 99 and 101 per cent accuracy. Meters above 2 in. were read semi-monthly and tested upon noting any falling off in volume registered. Two in. meters are tested in the field. **Robert B. Morse** of Hyattesville, Md., reported that 2 to 8 in. meters are read monthly and smaller sizes every six months. **Isaac S. Walker,** Consulting Engineer, and formerly of the Federal Water Service Company at Chester, Pa., reported that household meters have been allowed to run for 7 to 8 years without tests.

QUESTION: **"What is the life of ¾ in. and ⅝ in. meters?"**

REPLIES: **B. C. Little** said that he knew of meters that had served as much as 30 years if not longer. **H. E. Beckwith** of the Pitometer Company reported on 35-year records which had indicated the average life of meters would be 22 years and that there was little or no room for choice between the high grade meters reported on. **E. J. Canton** of the Badger Meter Company said that the cost of maintenance was the all important factor in determining the life of meters. If cost of repairs mounted to as much as $5.00 that would indicate it better to replace the meter than make the repair.

QUESTION: **"When laying mains in streets is a profile such as used in sewer construction of advantage?"**

REPLIES: **B. C. Little** said that Rochester practice was to put mains 4.5 feet below street but he thought that deeper than need be. **R. B. Morse** had found that the stipulated depth of 4 ft. was not always obtained in laying mains and therefore practiced laying by preparing profile just as in the case of sewer plans. Less accuracy in laying was naturally satisfactory but he had found it to be the only sure means of insuring proper depth of mains. **Robert C. Wheeler,** Consulting Engineer, said that where subsequent street or road grading had been anticipated he had used a profile map with happy results. Profiles had proven useful in laying large mains because grading to air release valves had been of value. On a distribution system fire hydrants could be installed at high spots to overcome air pocketing.

▼

Results of Pitometer Water Waste Survey at Erie, Pa.

A pitometer water waste survey for the purpose of determining the condition of the underground distribution system of the water works of Erie, Pa., was carried out in 1931. The survey brought out some interesting information, which is summarized as follows in the 1931 report of the Commissioner of Water Works of the city:

The local distribution system comprises 241 miles of mains, varying in size from 2 in. to 36 in. in diameter, and 32,000 service connections from ¾ in. to 16 in. in diameter. These connections equal in distance over 100 miles of service pipe.

This complete net work of mains and services was examined for leaks and it is interesting to note from the survey report that there were but four main leaks. These four leaks, however, totaled 285,000 gal. of water every 24 hours. When consideration is given to the fact that some of the distribution mains have been in continuous service since the starting of the water works in 1869 with additions each year until the present system was reached, a total of but four leaks proves the quality of the work done in the early construction of the works.

A total of 83 service connections were found to be defective about equally distributed between leaks in the street and leaks on the property of the consumer. Waste from this source equaled 637,000 gal. per day.

The total underground leakage detected and isolated by the survey totaled 922,000 gal. a day.

In connection with the underground survey a detailed inspection was made to determine the condition of fixtures within the buildings throughout the city and to measure the quantity of water being wasted in this manner. The report does not comment so favorably on the information obtained from this part of the survey as 2,069 defective fixtures were found which were wasting 1,525,000 gal. of water every day. The following is quoted from the report on the subject of house or fixture waste:

"Waste due to defective plumbing fixtures located during the survey amounted to 1,525,000 gal. per day. . . . While this waste has been temporarily stopped it is only a question of time before new leaks will develop as some of the plumbing fixtures were in very poor condition."

The average daily total consumption for Erie for 1930 was 24,882,000 gal. From the data obtained during the survey this consumption is divided as follows:

	Gallons per day	Per cent of total
Pump Slip	382,000	1.5
Wash Water at Filter Plant	632,000	2.6
Meter Consumption (Industrial and Commercial)	10,780,000	43.3
Under-registration of Meters	44,000	.2
Underground Leakage	922,000	3.8
House Waste	1,525,000	6.1
Allowable Leakage (3,000 gal. per day per mile of main)	723,000	2.9
Domestic Use and Unaccounted for water	9,859,000	39.6

The distribution of the day's consumption as shown in the above tabulation is exceedingly interesting, and aside from the prohibitive amount of house waste, is most satisfactory for an unmetered domestic supply.

The distribution of the day's consumption by services is divided as follows:

Low service, or that part of Erie north of 19th St. consumes 18,586,900 gal. As most of the industrial plants are on this service it should be noted that 48 per cent or 8,921,700 gal. of the total consumption is used by the industries.

The high service, that area south of 19th St. and north of 38th St. or Cooper Road and comprising largely residential districts uses 5,996,500 gal. or 24.1 per cent of the daily total.

The booster service, or the district south of Cooper Road and including Glenwood has a daily average demand of 298,600 gal.

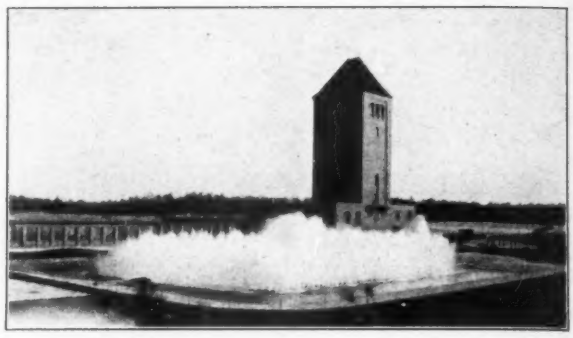
The following is quoted from the report regarding universal metering:

"We recommend that universal metering be adopted. Waste due to defective plumbing fixtures located during the survey amounted to 1,525,000 gal. per day. At $27.36 per million gallons, this represents an annual loss of over $15,000. . . . There was also considerable willful waste of water and considerable sprinkling after specified hours during the hot weather. As it is impossible completely to enforce the rules of the department in regard to the use of water, we believe that the only equitable way to sell water is by meter."

FILTRATION PLANTS

A Section Dealing with Their Design, Construction and Operation

Conducted by JOHN R. BAYLIS, Associate Editor
Physical Chemist, Bureau of Engineering, Chicago, Ill.



Raw Water Aerators, Providence, R. I.

AERATION

Part 2. Compounds Which May Be Removed From Water by Aeration

THE effect of films at the water-air interface on the rate of the escape of dissolved gases by aeration was discussed in Part 1. It was shown that the thickness of the films has great influence upon the rate of escape and that it is important to produce an enormous surface area to make the aeration very effective. The present article will show that there are not many compounds which produce taste and odor in water that may be eliminated by aeration. Those who have had experience in the aeration of water are aware that there are a number of taste and odor producing compounds which may occasionally be present in a public water supply that cannot be removed by aeration.

Where most of the characteristics of a compound are known such as is the case for carbon dioxide and hydrogen sulfide it is possible to predict with a fair degree of accuracy the reduction which may be accomplished with some certain system of aeration. However, there are so many tastes and odors occurring in water of which we have no knowledge of the compounds responsible that it is difficult to predict the improvement which will result from aeration, and the only way this may be determined is by actual trial.

Vapor Pressure of Liquids and Its Significance in Aeration.—The vapor pressure of a liquid is defined as the pressure at which the liquid and its vapor are in a state of equilibrium at some definite temperature. The vapor pressure of water at sea level and at 100° C. (boiling temperature) is 760 millimeters of mercury, or one atmosphere. If the vapor is not in contact with its liquid phase it may exist at any pressure lower, but if compressed until the vapor pressure is reached the pressure does not continue to be increased as the volume is further reduced but the gas is converted to the liquid phase. The vapor pressure of all liquids increase as the temperature is increased, and the *rate* of increase also increases as the temperature is increased. The vapor pressure of water at zero degree C. is 4.69 mm. of mercury, 17.36 mm. at 20°, 54.87 mm. at 40°, and 155.95 mm. at 60°. Data on the actual measurements of vapor pressure for a number of compounds are available in the chemical literature, and where points are shown on the curves in Fig. 1 they were taken from actual measurements.

About all one has to know to compute the vapor pressure of a compound for any temperature is to know the boiling point of the compound. In fact it is not necessary to know the boiling point just so long as the vapor pressure is known at some definite temperature. From this it may be predicted with some degree of accuracy whether or not the compound is one that may be removed from water by aeration. There, of course, are factors other than the vapor pressure which affect the reduction of dissolved compounds from water by aeration, but the vapor pressure is the most important factor for most compounds.

If there was a liquid which has the same boiling point as that of water, and the two liquids mixed in all proportions, the volume of the two compounds in the gaseous phase above the solution should be equal when the two solutions are mixed in an equal mole ratio. Reducing the amount of one of the liquids and increasing the other the ratio of the volume of the two compounds in the gas above the liquid should be in the same ratio as the mole ratio of the two compounds in the solution. If the solution was being sprayed into air which is already saturated with water vapor but contained none of the other compound, some of this compound would escape into the air but none of the water would.

It should be evident that it would be an almost hopeless task to remove very much of a compound from water by aeration if the boiling point of the compound was the same—or higher than that of water. The tendency for compounds to escape into the air increases as

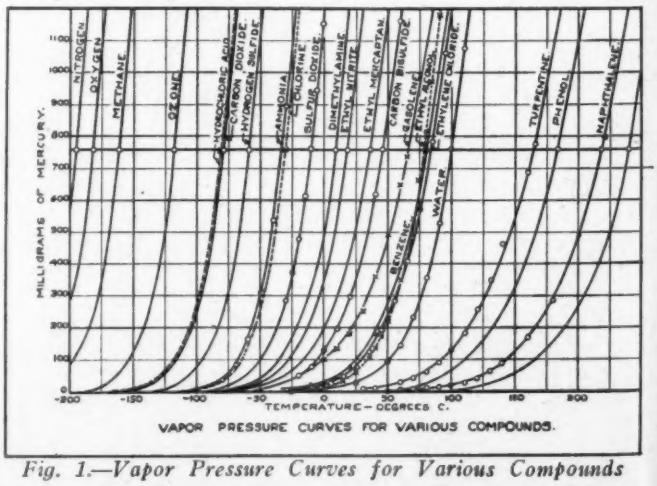


Fig. 1.—Vapor Pressure Curves for Various Compounds

their boiling temperature is lowered. It is not possible to name a certain boiling temperature less than which it would be economy to aerate and above which it would not be economy. It is somewhat like trying to set the best time of sedimentation for coagulated water in a filtration plant. The time which will figure most economical in one plant may not be the most economical for another plant.

Compounds Not Highly Soluble in Water.—When compounds are not highly soluble in water the vapor pressure for mixed solutions may not follow the usual vapor pressure laws, and the rate of escape into the gaseous phase may be more rapid than is the case for a solution that mixes with water in all proportions. Usually this rate is not enough to be of practical importance for compounds with a boiling point above that of water. This may be illustrated by evaporating water containing a very small amount of phenol. The proportion of phenol in the first distillate will be greater than it is in the original solution, even though the boiling point of phenol is 183° C. Phenol is soluble in water to the extent of about 6.7 per cent by weight at 16°. Should it be a compound which mixes with water in all proportions a lesser amount of phenol should have been expected in the first distillate even though the molecular weight is over 5 times that of water. When the solution contains less than 0.1 p.p.m. of phenol the first portion of the distillate will contain approximately 100 per cent more phenol than was in the original solution. This is in the direction of favoring the release of phenol from solution by aeration, yet it is too small to be of practical value. If some compound with a boiling point of 50 to 60° C. had the same characteristics as that of phenol it might be possible to effect a fairly good reduction by aeration.

The Boiling Point Must Be Low for Aeration to Be Effective.—The temperature of the water in our public supplies ranges from zero to about 25° C. It does not seem probable that aeration would be effective in materially reducing compounds from water which have a boiling point greater than about zero degrees C., though it has been stated that no certain figure can be set. If it requires only one part per million of a highly soluble compound with a boiling point of zero degree C. to produce an objectionable odor in water, and the water contains 5 p.p.m. of the compound, the most efficient system of aeration may not reduce the compound more than one to two p.p.m.; yet if this was a very insoluble compound the reduction probably would be very much more. It is believed that somewhere between 25 and 50 degrees for the boiling point of compounds is the upper limit in which effective aeration may be accomplished for any compound. The lower limit is very indefinite. Chlorine with a boiling point of —33.6 degrees is not materially reduced by aeration when the concentration in the solution is about the usual amount used in water treatment; that is, less than 0.5 p.p.m.† Hydrogen chloride with a boiling point of —85 degrees is not materially reduced by aeration when it is present in water to the extent of only a few parts per million, due to its high solubility.

The Boiling Point of a Few Chemical Compounds.—Table I gives the boiling point of a few compounds. The compounds marked with an asterisk (*) will produce taste or odor if present in potable water. Most of the compounds given are aromatic compounds, except those with a boiling point less than zero degree C. The solubility is given where such information could be found in the chemical literature.

†The alkalinity, organic content and ammonia content of waters have a distinct bearing on the degree of chlorine loss on aeration. The purer the water the more readily chlorine can be expelled.—Editor.

TABLE I—BOILING POINT, MOLECULAR WEIGHT AND SOLUBILITY OF A FEW COMPOUNDS.

Compound	Formula	Molecular Weight	Boiling Point Deg. C.	Solubility P.P.M. 0°C.	20°C.
Nitrogen	N_2	28.02	—195	29	19
Oxygen	O_2	32.00	—183	69	43
Methane	CH_4	16.03	—165	slightly soluble	
Ozone	O_3	48.00	—119	8,800	
Ethane	$CH_3.CH_3$	30.05	—86	Slightly soluble	
Hydrogen chloride	HCl	36.47	—83	very soluble	
Carbon dioxide	CO_2	44.00	—80	3,346	1,688
*Hydrogen sulfide	H_2S	34.08	—60	7,066	3,846
Ammonia	NH_3	17.03	—38.5	987,000	
*Chlorine	Cl_2	70.91	—33.6	fairly soluble	
Formaldehyde	H.CHO	30.02	—21	very soluble	
Methyl nitrite	$CH_3.NO_2$	61.03	—12		
Sulfur dioxide	SO_2	64.06	—10	228,300	112,800
*Methyl amine	$CH_3.NH_2$	31.05	—6.7	very soluble	
Butane	$CH_3(CH_2)_2CH_3$	58.08	1	very insoluble	
*Trimethyl amine	$(CH_3)_3N$	59.08	3.5	very soluble	
†Methyl mercaptan	CH_3SH	48.10	5.8	very soluble	
*Dimethyl amine	$(CH_3)_2NH_2$	45.06	7.2	very soluble	
Ethyl nitrite	$C_2H_5NO_2$	75.05	17	slightly soluble	
Aldehyde	CH_3CHO	44.03	20.8	all proportions	
†Pentane	$CH_3(CH_2)_3CH_3$	72.09	32.6	360(16°)	
Carbon bisulfide	C_2S	76.13	33	2,200	
*Ethyl mercaptan	C_2H_5SH	62.11	36	15,000?	
Acetone	$CH_3.CO.CH_3$	58.05	56.5	all proportions	
†Hexane	$CH_3(CH_2)_4CH_3$	86.11	69	140(15°)	
Ethyl alcohol	C_2H_5OH	46.05	78.4	all proportions	
†Benzene	C_6H_6	78.05	80.4	700	
Ethylene chloride	$CH_2Cl.CH_2Cl$	98.95	84	slightly soluble	
*Thio-acetic acid	$CH_3.COSH$	76.10	93	all proportions	
†Heptane	$CH_3(CH_2)_5CH_3$	100.12	98.4	52(15°)	
†Toluene	$CH_3.C_6H_5$	92.06	110.7	47,000(16°)	
*Allyl sulfide	$(CH_2:CH.CH_2)_2S$	114.14	139	slightly soluble	
Cymene (1,2)	$CH_3.C_6H_4.CH(CH_3)_2$	134.11	157	slightly soluble	
*Tetramethylene-diamine	$NH_2(CH_2)NH_2$	88.11	159		
*Chlorophenol (o)	$Cl.C_6H_4.OH$	128.5	176	slightly soluble	
*Terpinene	$C_{10}H_{16}$	136.16	180	slightly soluble	
*Phenol	$C_6H_5.OH$	94.05	183	67,000	
†Aniline	$C_6H_5.NH_2$	93.06	184		
*Cresol (o)	$CH_3.C_6H_4.OH$	108.06	191	25,000(33°)	
*Brom-phenol	$Br.C_6H_4.OH$	172.96	195	slightly soluble	
†Napthalene	$C_{10}H_8$	128.06	218	35,000	
†Citronellol	$C_{10}H_{20}O$	156.15	222	slightly soluble	
*Indole	C_8H_7N	117.06	253	slightly soluble	
*Skatole	C_9H_9N	131.08	265	slightly soluble	
†Naphthol (a)	$C_{10}H_7OH$	144.06	282	slightly soluble	

†May produce a taste, but there is no case on record which the writer could find where the compound has given trouble in a water supply.

Solubility and Its Effect Upon Aeration.—It has been stated that the solubility of a compound in water materially influences its removal by aeration. The data given in Part 1 for the reduction of CO_2 from falling drops of water showed a reduction in the percentage reduction as the concentration of CO_2 was decreased. This percentage reduction would theoretically reach zero when the water is in equilibrium with the CO_2 in the air, which is approximately 0.5 p.p.m. of CO_2 in solution. If water is one-tenth saturated with CO_2, and a certain system of aeration reduces this amount one-half, we do not have information that some other compound which is only slightly soluble will be reduced one-half when the concentration in the water is one-tenth saturation, though it seems probable that this may be approximately the expected reduction if the compound was one with a boiling point near that of CO_2. The fact that the CO_2 is thought to be in combination with water to form carbonic acid (H_2CO_3) may have some influence upon the results.

There is no information on the percentage reduction by aeration of compounds only slightly soluble in water, and it may be that the factors which have the greatest influence with the highly soluble compounds are not the ones which have the greater influence with the weekly soluble compounds. There may be a few weekly soluble compounds which require a fairly high percentage saturation to produce a taste or odor, and a reduction of the compound 20 to 25 per cent may be sufficient to eliminate the taste or odor. Should there be such compounds present it may be possible to eliminate or greatly reduce the taste or odor from compounds that have a boiling point probably as high as 50° C.

The Boiling Point of the Various Organic Compounds Usually Increases With the Number of Carbon Atoms.—In any homologous series of organic compounds the boiling point usually increases with the number of carbon atoms present in the compound. This is particularly significant, for we should not expect compounds of a complex nature to have boiling points low enough to indicate that they may be removed from water by aeration. In the saturated hydrocarbon group methane with one carbon atom boils at —160° C., while pentane with 5 carbon atoms boils at 36 degrees. Ethylene, in the olefine group, has two carbon atoms and boils at —103°, while amyline with 5 carbon atoms boils at 39°. Methyl alcohol with one carbon atom boils at 66° and propyl alcohol with 3 carbon atoms boils at 97°. Methyl amine boils at —6° while propyl amine boils at 47°. In the fatty acid group, formic acid with one carbon atom boils at 101° and butyric acid with 4 carbon atoms boils at 162°. Benzene with 6 carbon atoms boils at 80.4° while xylene with 8 carbon atoms boils at 138° to 142°.

Practically all compounds having a boiling point less than zero degree C. are fairly simple in structure, and not many of the organic compounds contain over two carbon atoms. Very likely nearly all of the compounds with a simple chemical structure and containing only two or three carbon atoms are known to chemists, and their characteristics are fairly well understood. It therefore seems probable that the unknown aromatic compounds which give off offensive odors or will produce taste in water are usually of a fairly complex nature and are compounds which have a boiling point so high they cannot be easily or economically removed from water by aeration.

Significance of the Boiling Point and Vapor Pressure.—It may seem to the reader that undue stress is being placed upon the boiling point and the vapor pressure of compounds. It is these two factors and the solubility of the compounds which enables one to predict fairly accurately what to expect by aeration. A knowledge of these factors also shows that we should not expect aeration to be effective in completely removing a large number of the taste and odor producing compounds which may be present in water.

The vapor pressure curves are given to show that all liquids have the same general characteristics and that the boiling point of a compound can be used to predict whether or not it may be removed by aeration. We should not expect to find a compound which has a fairly high boiling point, yet will have a fairly high vapor pressure at a temperature considerably below the boiling point. The vapor pressure drops off quite rapidly as the temperature is lowered just below the boiling point, then the rate of drop decreases the nearer one approaches the zero vapor pressure. This is shown very clearly by the curve in Fig. 1.

These remarks refer to the escape of the compound into the air as a gas and not to changes which may be produced by the water absorbing oxygen from the air. It is known that a few compounds are easily oxidized.

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City Held Liable for Sewage Pollution of Stream

Public Health Reports of May 20, 1932, contains the following interesting item regarding the decision handed down Nov. 10, 1931, by Oklahoma Supreme Court in the case of Oklahoma City vs. West, 7 P (2nd) 888:

In an action brought by a riparian owner against a city to recover damages resulting from the discharge of unpurified sewage into a stream, the judgment was in favor of the plaintiff. Certain points decided by the supreme court are well set forth in the official syllabi prepared by the court, and those portions of such syllabi which are of interest from a public health standpoint are as follows:

In a suit to recover damages caused by the discharge of unpurified sewage into a water course to the damage of a riparian owner, a contention that, since a sewer system is a permanent structure, in the absence of an allegation of negligence in the adoption of the plan of construction of the sewer system or in a failure to construct the system in accordance with the plan adopted, the nuisance should be considered permanent, is unsound, for the damages in such case are not caused by the so-called permanent structure but by the manner of its use. City of Mangum v. Sun Set Field, 73 Okl. 11, 174 P. 501, to the contrary, is overruled.

Judicial notice is taken of the fact that sewage can be easily and successfully purified by the use of modern appliances, so that a nuisance, caused by the discharge of unpurified sewage into a water course, is, as has heretofore been declared by this court, a temporary nuisance within the rule that a nuisance is temporary that can be abated by the expenditure of money or labor.

Where work is required or authorized by the legislature and a nuisance is not the necessary result of the performance of the work, it can not be contended that the nuisance is legalized and that the right to recover damages for the nuisance is based upon a constitutional provision that private property shall not be taken or damaged for public use without just compensation, but the damages are recoverable for a common law tort which has not been legalized, and, if the commission of the nuisance is unnecessary, it is unnecessary to allege that there was negligence in the adoption of the plan for the work or in the construction of the work in accordance with the plan adopted, as the burden of showing necessity is upon the defendant, and an allegation that the nuisance can be abated by the expenditure of money or labor indicates that the commission of the nuisance was unnecessary and that its continuation is unnecessary.

It is not within the power of a municipality, guilty of the commission of a nuisance by discharging unpurified sewage into a water course to the damage of a riparian owner, to elect to continue the nuisance and require the nuisance to be held to be permanent. An indication to the contrary in Page v. Oklahoma City, 129 Okl. 28, 263 P. 448, is disapproved.

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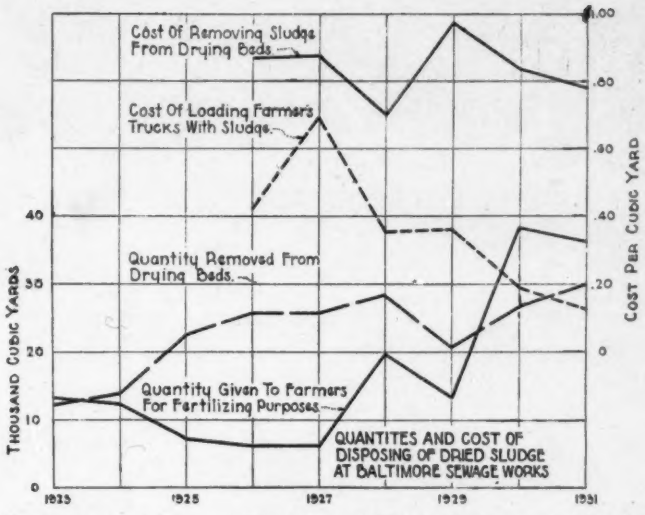
Letters to the Editor

To the Editor: May I correct the reference on page 173 of your May issue, regarding the use of iron salts as coagulants in combination with lime for the removal of manganese from water.

My statement was that either ferrous sulfate or "chlorinated copperas" was a better coagulant for turbid waters containing manganese than was ferric sulfate. This was because our trials showed that the more rapid formation of coagulum in the case of ferric sulfate was attended with a loss of efficiency.

ROBERT SPURR WESTON,
Consulting Engineer, Boston, Mass.

SLUDGE DISPOSAL AT THE BALTIMORE SEWAGE WORKS



Quantities and Cost of Disposing of Dried Sludge at Baltimore Sewage Works

ONE of the problems at large sewage works, where the solids are removed by sedimentation, is that concerning the economic and satisfactory final disposal of the digested or partly digested sludge. This ever present problem has, at least for the time being, been partly solved at the Baltimore works. Large quantities of the wet sludge have been pumped into lagoons, which have later been covered with dirt, graded and converted into attractive lawns. Although considerable quantities of the material are lagooned, the major portion is given to farmers, who haul it for distances as great as 20 miles. The sludge in one of these lagoons, after a period of nine years, has dried sufficiently to permit its removal by farmers.

The sludge at the Baltimore sewage works is collected in preliminary sedimentation tanks and digested in separate sludge tanks. Much of it is then dried on sand beds, and finally removed to a sludge dump. During the last five years the volume of wet undigested sludge has varied from 154,000 to 184,000 cu. yd. when based on a 90 per cent water content, and the quantity removed from the sludge beds during this same period has varied from 20,600 to 28,100 cu. yd.

During the first three or four years that the sewage works were operated, the quantities of both undigested and dried sludge were small, and the satisfactory disposal of this material was a simple problem. A few years later, however, the quantities became so great that ways of permanently disposing of it were studied. For a 5-year period from 1916 to 1921 considerable quantities of the sludge were sold to a private company,[1,2] that heat-dried the material and sold it as a filler for fertilizer but from a financial standpoint this plant proved a failure. Since January, 1923, the dried sludge, which contains about 2 per cent nitrogen as ammonia, has been given without cost to farmers and others, who use it for fertilizing purposes.

Although the farmers had been using the sludge since the sewage works were first put in operation, the quantities removed were small compared with the total output. One of the difficulties was that there were no adequate means of quickly loading the farmers' trucks and wagons. In order to make this operation easier, an old

[1]Keeker, C. E. "Sludge Reduction at the Baltimore Sewage Treatment Plant," Public Works, 52:209.
[2]Keefer, C. E. "The Heat Drying of Sludge at the Baltimore Sewage Works," Eng. News-Record, 96:238.

Fig. 1—Sludge Lagoon, 8 Ft. Deep, Being Landscaped, Baltimore Sewage Works

Fig. 2—Sludge Being Removed from Lagoon

5-ton locomotive crane was put in service at the sewage works in August, 1922. During the following year the quantity of sludge removed had increased to 13,430 cu. yd. as compared with 6,270 cu. yd. distributed during 1922. The operation with this crane proved to be such a success that a new one was purchased in 1927 at a cost of $7,500 to replace the old unit, which had worn out.

The quantity of sludge given away has been gradually increasing, and has totaled over 38,000 cu. yd. in 1930, amounting to about 45 per cent more material than was removed from the drying beds during that year. The difference represents sludge removed from old lagoons or the dump.

Lagooning Sludge

Since 1919 it has frequently been necessary to find additional storage space for undigested sludge due to the lack of sufficient digestion tank capacity. Large quantities of both raw and partly digested sludge have been pumped into four lagoons. The first of these to be put in service was a narrow strip of ground about 50 by 800 ft. By building an earth dam at one end of this area a storage space about 8 ft. deep was provided. Both raw and partly digested sludge was pumped into this lagoon for a period of 4 or 5 years. At frequent intervals large quantities of water were siphoned off to make room for more sludge and also to dry up the contents. During that time the sludge continued to dry and become more compact. Recently a layer of earth varying from 12 to 24 in. thick was deposited on the top of this sludge. This area is now being graded (see Fig. 1), and next year will be planted with grass and made into a lawn.

A similar but somewhat smaller area was filled with a mixture of sludge and earth in 1921. This tract was later graded and planted with shrubbery and it presents a neat and attractive appearance.

In 1922 it again became necessary to provide additional sludge storage. There were several acres of low-lying ground, which could be easily converted into a sludge lagoon at a low cost. A 36-in. concrete pipe line, 1,060 ft. long, was laid down the center of the area to provide for the run-off from the up-stream territory. The tract was cleared of timber, and two earth dams, one at each end of the area, were constructed. When completed, the total capacity of the lagoon was about 41,000 cu. yd. Raw sludge, which had a moisture of about 92 per cent, was mixed with a small quantity of digested material, and then pumped into the lagoon.

After a period of years the sludge became thoroughly digested and large quantities of water drained off and evaporated. The material now has a moisture of about 70 per cent, and it is being hauled away by farmers (see Fig. 2). Lagooned sludge possesses one advantage over air-dried sludge in that it is free from sand, and has a higher nitrogen content. Sludge removed from sand beds almost always contains a certain quantity of sand, regardless of how carefully the material is removed.

Truck farmers, who live in the vicinity of the sewage works, are the biggest users of the sludge. They put it on land where a variety of crops, such as spinach, kale, tomatoes and cabbage, are grown. The sludge has also been used with success on the lawns of the city parks, the municipal filtration plant and the sewage works. In 1928 about 6,500 cu. yd. of the ma-

QUANTITIES AND COST OF DISPOSING OF DRIED SLUDGE AT BALTIMORE SEWAGE WORKS

	Sludge Removed from Drying Beds			Sludge Used for Fertilizing Purposes		
	Quantity	Cost of Removal		Quantity	Cost of Removal	
Year	Cu. Yd.	Total	Per Cu. Yd.	Cu. Yd.	Total	Per Cu. Yd.
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1926	25,703	$22,298.15	$0.867	6,121	$2,561.34	$0.42
1927	25,591	22,447.81	0.877	6,141	4,242.99	0.69
1928	28,081	19,515.25	0.695	19,946	6,974.69	0.35
1929	20,641	20,080.06	0.973	13,120	4,674.75	0.36
1930	26,728	22,335.73	0.835	38,229	7,293.96	0.19

terial were used in place of top soil in one of the municipal parks.

During the past few months a plant for the manufacture of aeroplanes, located about 4 miles from the sewage works, has started to take 10,500 cu. yd. of the sludge. They are using the material with considerable success in place of top soil on an aeroplane field adjacent to their plant. The sludge is being uniformly spread over the ground, mixed with the soil by means of a disk harrow and then tooth-harrowed (Fig. 3). This process of harrowing is repeated until the sludge is thoroughly mixed with the soil. The ground is then ready for seeding. The quantity of sludge used is equivalent to a uniform layer 1 in. thick, or about 134 cu. yd. per acre.

If the demand for the sludge by farmers and others continues as it has during the past few years, all of the excess material at the sewage works will be disposed of within two or three years, and the total annual output of dried sludge will be distributed for fertilizing purposes.

The question has been frequently asked as to the desirability of selling the sludge in place of giving it away. During the first few years that the sewage works were in operation the sludge was sold for 25 ct. a load. It was believed by those who then had supervision over the works that additional revenue could be obtained by increasing this charge to 35 ct. When this increase was made, however, the farmers practically stopped taking the sludge. Since 1921 no charge has been made for the material.

It is of prime importance to have the sludge removed from the plant as soon as possible. Where this procedure is not accomplished, the sludge frequently has to be rehandled at considerable expense. the material presents an unsightly appearance, and valuable land is occupied that might otherwise be used for a more suitable purpose.

The sewage works is under the general supervision of B. L. Crozier, chief engineer, and George E. Finck, sewerage engineer. The writer is in charge of the design, construction and operation of the works, and G. K. Armeling is the superintendent.

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COST FOR POWER IN PUMPING VS. PUMP AND MOTOR EFFICIENCY

By GEO. B. MASSEY, C. E.

**Vice-President,*
Randolph-Perkins Co., Engineers,
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THE following nomographic chart has proven very useful in solving problems in pumping operations—proposed or existing. It is submitted for publication in hopes that it may prove of value to the readers of WATER WORKS AND SEWERAGE.

Where the electric rate and the dynamic head on the pumps and the cost of power to pump 1,000 gallons are known the overall efficiency of motor and pump can be quickly determined.

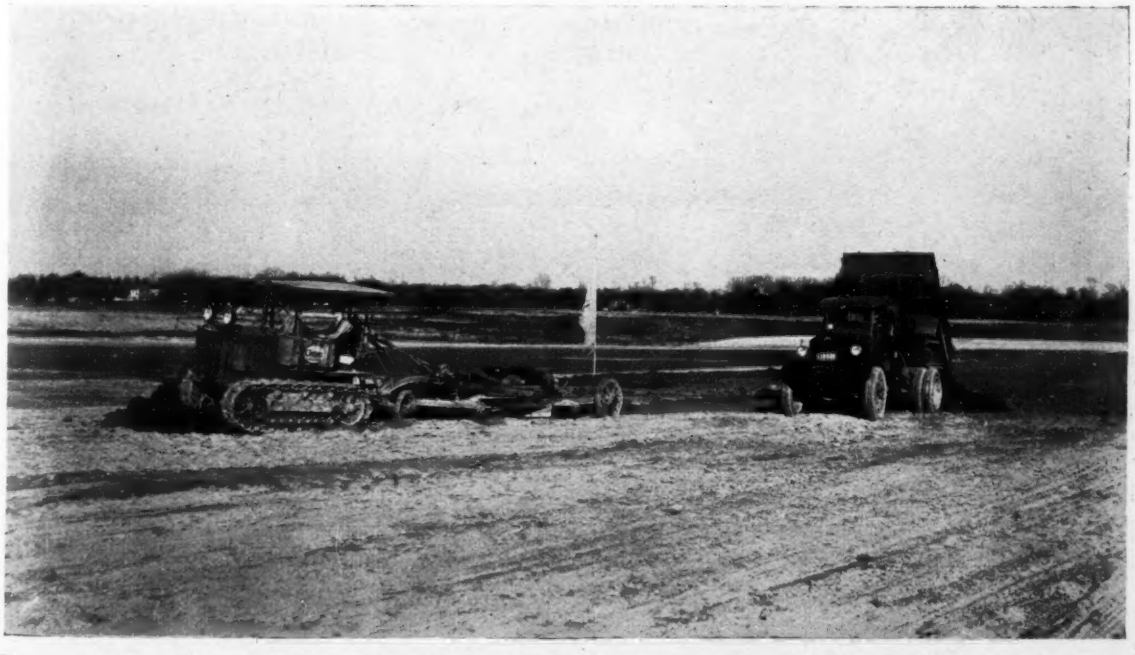


Fig. 3—Sludge Being Applied to Fallow Ground Preliminary to Seeding with Grass at Glen Martin Airport

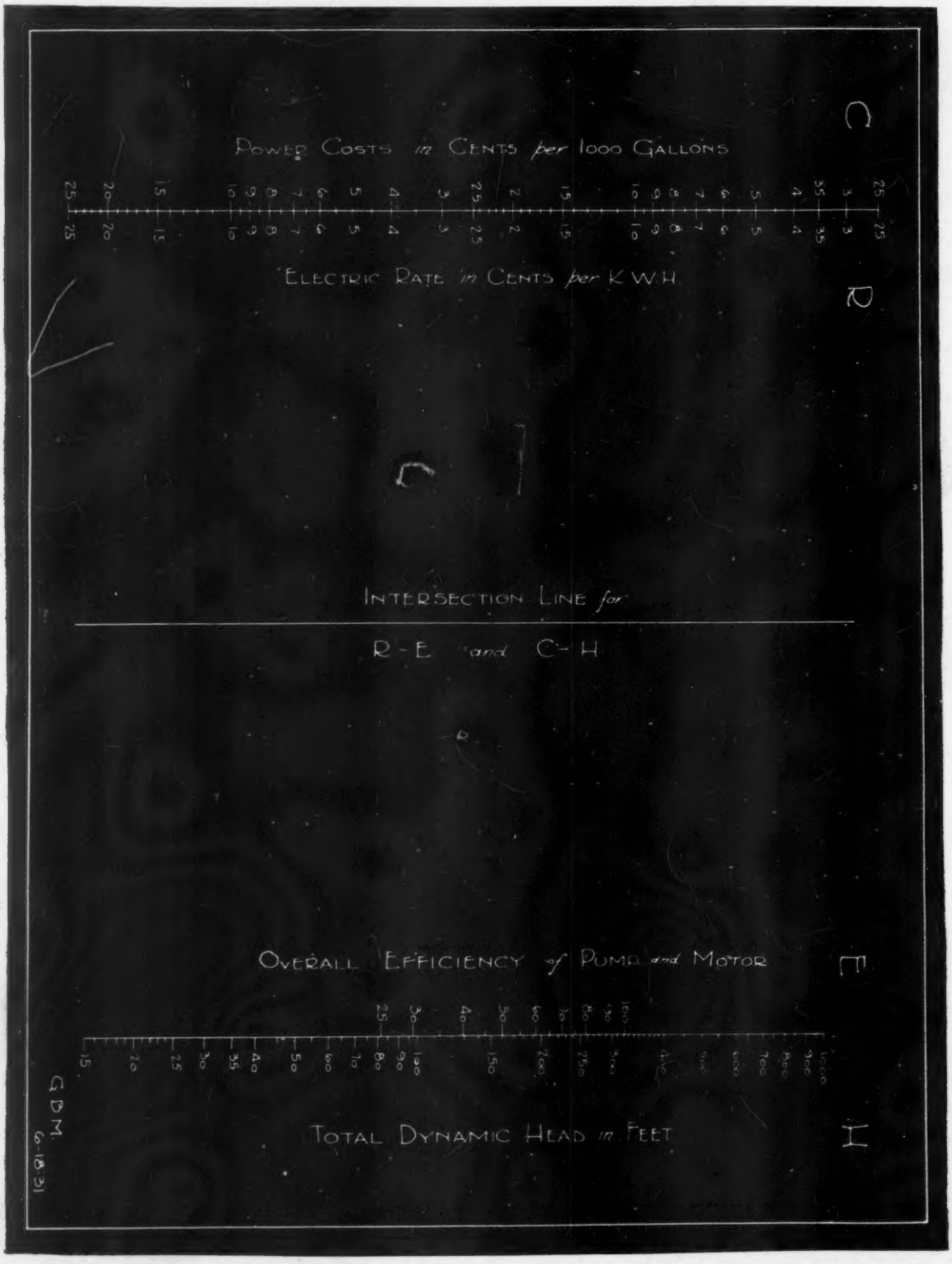
Directions:

(a) To Find Efficiency of Pump and Motor Unit. Lay straight-edge to pass through dynamic head on scale (H) and power cost per 1,000 gallons pumped on scale (C). Make dot on "intersection line" where straight-edge crosses. Revolve straight-edge around dot to pass through electric rate on scale (R). The straight-edge will pass through overall motor and pump efficiency on scale (E).

Example:

Power Cost (C) = 2.0c per 1,000 gallons
Dynamic Head (H) = 300 ft.
Electric Rate (R) = 1.333c per K.W.H.
Overall Efficiency (E) = ± 62%

(b) To Find Estimated Cost of Power for Pumping. Lay straight-edge to pass through electric rate (scale R) and overall pump and motor efficiency (scale E). Make dot on "intersection line" as before. Resolve straight-edge around the dot to pass through the dynamic head (scale H). The straight-edge will pass through the power cost per thousand gallons on scale (C).



Nomographic Chart That Has Proven Very Useful in Solving Problems in Pumping Operations—Proposed and Existing

WELLS AND THE PART THEY PLAY IN OUR WATER SUPPLY

By W. R. McGREW

Well Driller,
Thomasville, Ga.

WELL drilling is one of the oldest arts. It dates back to 600 B. C., as recorded by Confusius; and, has played a very important part in the history of men. Water wells were social and religious shrines of the ancients.

One of the early wells mentioned in the Bible was "Joseph's Well" at Cairo, an example of early engineering and skill. This well was 18 ft. by 24 ft. and 295 ft. deep, quarried out of the solid rock. The shaft was broken in the middle, the upper part was 165 ft. deep, the lower 135 ft. deep. The well was pumped by two chain and bucket pumps of stupendous size; motive power was supplied by oxen. The limitation of the pump apparently made necessary the offset in the well. Probably, a chain longer than 165 ft. was deemed impractical by ancient engineers. A circular ramp was excavated around the upper portion of the well to permit the oxen to reach the 165 ft. level in order to operate the lower chain, which delivered the water into a basin at that point. From there is was raised by the buckets of the upper chain to the surface. The excavating of this well was attributed to the builders of the pyramids and must have been expensive as compared with our modern methods of drilling wells and pumping water.

The oldest drilled well in Europe was in northern France, and known as "Artois," near the town of Lilliers, and from this name came our word "Artesian." In 1818 the French Government appropriated money for well drilling and their engineers built machinery which was possibly the start of the percussion drills. At Grenelle in 1832, they started a well 40 ins. in diameter; and, in ten years finished it (8 ins. in diameter) to a depth of 1780 ft. This well spouted water 120 ft. into the air and flowed 880,000 gallons per day.

In 1808 the first well was drilled in this country at Buffalo Lick, Va. This well was drilled by means of the spring pole outfit, which, after many refinements, became the modern well drilling machinery. This well was finished to a depth of 58 ft. after several months of hard work, and furnished a good flow of brine.

A well has recently been drilled in California, known as "No. 2-A Hobson." It was drilled to a depth of 10,030 ft. Water was found at the bottom.

From these deep wells we learn the following important facts: The temperature increases about 1 degree with each 55 ft. in depth; facts about the formation of the earth; depths from which water can be secured; and, the practical ways of drilling and carrying on exploration work. The business of well drilling has made its greatest strides in the last 100 years and today is prepared to meet almost any demand that might be made on the industry.

Two Major Classes of Wells

Wells may have two classifications. Those deriving water from strata or crevices in the rock formation; and, those that draw water from sand strata.

The first class is simpler and for the greater part troublefree since the water comes through the rock which has very little tendency to cave in or to fill up.

The second class, or sand wells, requires strainers which must be renewed at intervals, and due to the sand filtering through the strainer, the wells must be cleaned out. From this last class of wells comes a large part of our water supply. Especially, is it necessary that sand wells be drilled by experts.

For years the drilling of wells has all too frequently been contracted to the man who offers the lowest price, regardless, of his ability or equipment. As a result many of our wells have failed, or have been too small for modern pumps, or too crooked for their successful operation.

I admit that the drilling industry should have been handled better, but it was not.

In drilling wells in a large territory, ranging from Alaska to Russia, and in several sections of this country, we have found that very little, if any, care has been taken to secure the best water supply. However, the regulations which different state health departments are forming will soon safeguard your water supplies.

Suggested Regulations

We wish to suggest some things which it might be wise to incorporate in our state laws.

1. Every well-driller should be licensed by the state, for on him depends to a large degree the safety of your water supply. At the same time he can be of assistance to your Board of Health.

2. A log of each well should be kept on standard log forms to be supplied by the state, so that they will be uniform and easily accessible. These logs would present valuable information about the water supply and the geological formation in the state. A log should contain the following information:

A. Diameter and trade description of the well-casing at the top and bottom of the well, stating where and why each reduction was made; length of each line of casing, how it is sealed, packed or seated at the top or bottom.

B. Kind of shoe that was used, if any.

C. Depth at which each formation was encountered, the thickness of each, color, name and description of each material.

D. Description of each water stratum passed through, giving approximate capacity, quality of water, and reason for casing it off if this has been done.

E. How the bottom of the well is finished. If it is in sand or gravel, state the kind of screen, diameter (inside and out), length of the slot-opening or mesh, how it is set in place, how the bottom is closed, how the top is sealed to casing, and what method was used in developing the well. If finished in rock, state the kind of rock, how deep it was drilled into and what sized hole.

F. Straightness of well, how it was tested.

G. How the well yield was tested, what its capacity is, its drawdown and the length of test.

H. How the well was finished at the top.

I. Other details such as whether the well was dynamited or not, whether the pipe was punctured or telescoped casing, etc.

J. Samples of each formation passed through should be preserved and sent to the state geologist.

A graphic log of every well is almost invaluable.

Installation of pumps in undrained pits should be discouraged, all well tops must be sealed.

Well Contractor Should Supply Proper Pump

We believe that in contracting for your wells you would profit, first, by securing a reliable contractor, and if a pump is required for pumping the water from the well, it should be furnished by the same contractor. Especially is this an important matter to the smaller cities and firms, for they seldom have an engineer. The contractor has an undivided responsibility in that case and all that you have to look out for are for the results required in the contract.

We believe that the practice of using wells for drainage purposes should be regulated by the state because in many cases they become a source of contamination to a water supply.

During the last few years we have drilled many of these drainage wells. In one city we drilled two ten-inch wells, which carry off the city's sewage after it has been passed through septic tanks. In the same city most of its storm water goes into wells. Just last year we completed four 16-in. wells, 300 ft. deep, near Valdosta, Georgia for the purpose of draining a 250-acre lake, which the United States Department of Fisheries is converting into a fish hatchery. This method of drainage is in many cases very economical, but it should always be carefully supervised.

We believe that the state should regulate the use of ground water, especially, in sections where there are flowing wells, for often these wells are allowed to flow when not in use and as a result the water head is reduced, and often that section has to resort to pumping eventually and often to other means of securing their water supply. It is a false idea to believe that artesian supply is inexhaustible. We wish to emphasize again that the conserving of the supply of underground waters is necessary, especially in sections having flowing wells.

A notable example of why we urge conservation is found in North and South Dakota, where once wells had a pressure from 100 to 200 lbs. to the square inch. This pressure has dropped to almost nothing in most of the wells, and, in some cases the supply has to be pumped. Securing a good water supply is one of our greatest problems, and it must hold our constant attention. Just how important it is may be seen by referring to the following:

It is estimated that there are 6,000 cities and towns in the United States which secure their water supply from drilled wells, besides that used by irrigation plants. In one section of Texas alone, there are 1,000 wells supplying water for the rice fields, pumping over 1,000,000 gals. per minute. Possibly the largest city using water from wells is Brooklyn, N. Y., with a consumption of more than 100,000,000 gals. per day. It is estimated that there are some 17,000,000 people who secure their water supply from wells, and the number is rapidly increasing.

With this tremendous consumption before us, we might look at the other side of this question and see just where this water comes from.

In sections where the formation is sandy or porous, and where the land lies rather level, or even where lakes or ponds are found, such as we find in South Georgia and Florida, we may expect a very large percentage of the water that falls to be stored up; possibly as much as 30 per cent. The other part of this rainfall evaporates or is taken up by trees and plants. So we see that in a section like this where often the rainfall will run well over 50 in. each year, we would have something like a 1,000,000,000 gals. per square mile annually and that no serious shortage could be expected from wells that are being pumped. However, the head may be reduced as the years pass. But, on the other hand, in mountainous sections and where the land formation is very hard clay on top, most of the rainfall will run off, causing a limited storage which often has to pass through crevices in the rock or porous strata for long distances before we tap it by well. The cause of this movement of the underground waters, is mostly by gravity through these cavities, but capillarity may be the cause of movement through sand and plants.

How deep may we expect to find water? The exact answer is undetermined. Water has been found as deep as man has ever penetrated, and that has been some 10,000 ft., but the supposition is that after a certain depth is reached—say five or six miles—the pressure will be so great that the pores or cells of the rock will be closed, thus preventing the storage of water.

The only formations that can be relied upon for large water supplies are sand, gravel, conglomerates, porous lime rock. The crystalline rocks, including granite and gneiss, have very little water and this is stored up in cracks and crevices which are very hard to find, so in these sections, in which the last formations are found, the well driller will not guarantee any large supply of water. In the porous formations, however, he will make guarantees and feel reasonably sure of being able to fulfill them. Sometimes he will secure wells that will supply 8,000 gals per minute.

It has possibly been the lot of many of you, as water works superintendents, to find that the water pressure in part of your system has fallen below requirements, still you are prevented from enlarging your mains because of the lack of finances. At the same time you may require a larger supply of water, and although you may have enough money to meet one of the needs, you need both.

In this case, we believe that with the modern pumping equipment which may be operated automatically, a new well and pump will meet both requirements, by placing the wells in different sections of the city. In this way, the need of new and larger mains may be eliminated; the cost of tearing up your streets saved, and a new source of water secured, which would often prevent the pumping down of the head and assure you of a continuous supply.

Acknowledgment—Excerpts from a paper read before the Southeastern Section of A. W. W. A., Atlanta, Ga., March, 1932.

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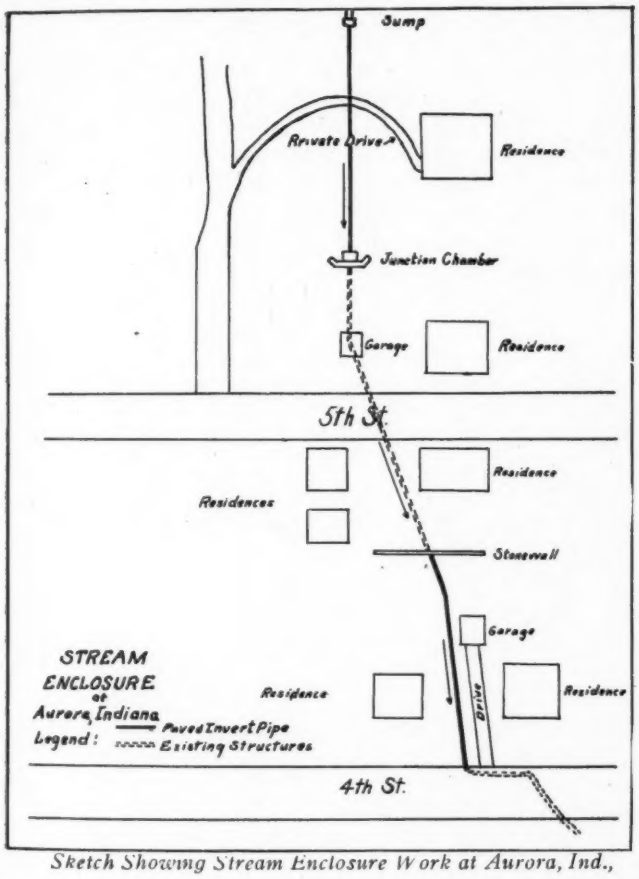
CITY TO SPEED PUBLIC WORKS—According to the Los Angeles *Chronicle* as a definite aid to the unemployment situation in Los Angeles, the Board of Public Works has announced that expenditures of $18,000,000 in improvements will be made throughout the city during this fiscal year. The entire $3,000,000 bond issue as well as the regular $15,000,000 appropriation will be expended in an effort to increase employment.

ENCLOSING AN OPEN STORM WATER DRAIN STOPS WASHING AND FLOODING

By RALPH PEARSON*

LIKE many cities situated along the banks of the Ohio River, Aurora, Ind., is built on hills which commonly flank the river along this portion of its course. In the northwest portion of the city, in the residential district, there had been for years an open stream which from time to time has been the source of considerable trouble.

Due to its steep fall and the quickness of the runoff from the watershed which it drains, it has been necessary to confine this stream to prevent washing damage to



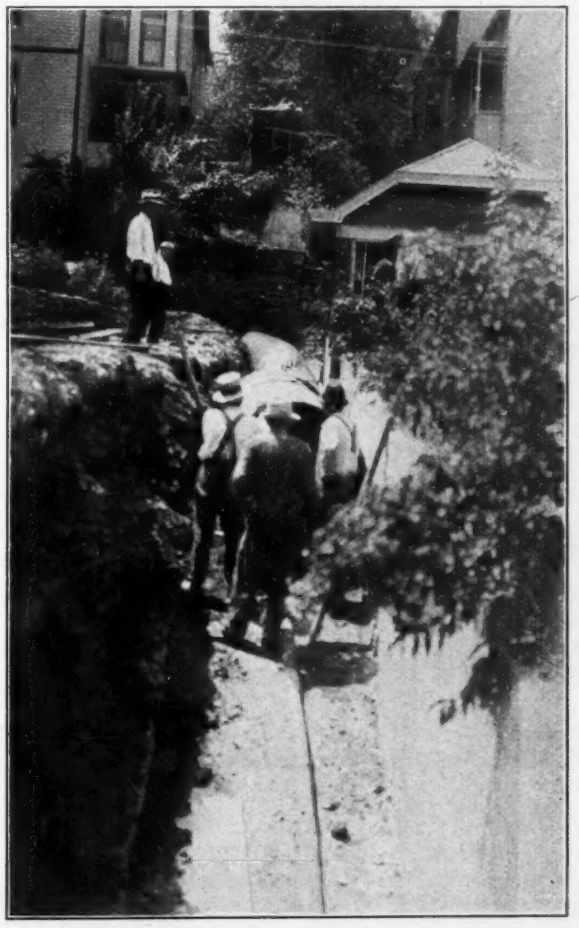
Sketch Showing Stream Enclosure Work at Aurora, Ind.,

the properties which it passed through. In the past these measures have ranged from complete enclosure in masonry structures to merely lining the open channel with rock to prevent washing during times of heavy rains. For a while these measures proved satisfactory, but as time passed by and the structures were subjected to the repeated attacks of rushing water pouring down from the heights above, stones were dislodged and carried down stream by the swift current. At 4th St. where the channel makes an abrupt turn before it passes under the street (see sketch), the force of the current was lessened. The larger of the rocks were deposited here and at times blocked the channel causing the water to back up into the yards of adjoining residences and in some cases to wash across the roadway into the yards and cellars of the residences on the lower side of the street.

As can be seen from the sketch showing the neighborhood affected, the stream in question passed close to a number of residences. Enclosing the stream in a satisfactory structure would not only stop the flooding but would improve the appearances of the properties through which the stream passed and make additional space for lawns. This lead to agitation, which eventually resulted in a decision to enclose that portion of the stream located between 4th St. and the existing enclosure which passed under 5th St.

For this purpose there were two plans under consideration: To effect the enclosure with some type of pipe, or build a monolithic structure that would serve a similar purpose. In considering the latter plan, it was decided that such a structure would necessitate the complete removal of the old structure before construction could be started. This would add to the cost of the improvement. By using a ready built structure the improvement could be completed promptly, and for this reason would not be so greatly dependent on the uncertainties of the weather which might cause considerable damage to the other type before its construction could be completed.

In looking for a suitable material to effect the enclosure, corrugated metal pipe was chosen as being easily installed and offering a satisfactory anticipated service life. Since an installation of such a steep grade would be subjected to severe erosive wear, it was thought that additional years of service could be secured by using a



Installing 48 in. Corrugated Drains Through Private Properties in Aurora, Ind.

*Armco Culvert Mfgrs. Assn., Middletown, Ohio.

product especially designed to meet the wear to which the installation would be subjected. Armco paved invert pipe, which has the invert protected by a pavement of wear-resisting asphalt was selected for the duty. Pipe of 48 inches in diameter was of ample size to meet the requirements of this location.

Installation

The pipe was delivered directly to the job by trucks and placed by city forces. After cleaning out and leveling the stream bed, the pipe was placed by hand. Joints were made by a special connecting band.

The completion of this portion of the enclosure brought out the advantages of this type of construction for the particular purpose, and, as there were still other portions of the ditch further upstream which were yet unenclosed, trouble could still be expected by stones washing down

Protection Sump at Upstream End of 48 in. Storm Water Drain

through the completed installation. Then too, enclosing the portion above 5th St. would permit the filling in of a large ravine and the elimination of a worn-out bridge under a drive to a nearby residence. Because the enclosure of this particular portion was of considerable advantage to the abutting property owners, they agreed to pay half the cost of enclosing an 110 additional feet of the stream. Part of this improvement included the building of a junction chamber which joined the new enclosure to the old masonry enclosure already in place, and providing an inlet for the surface water.

To guard against stones entering the new structure a sump was built at the upstream end of the pipe and serves to intercept all stones that might be washed loose and will prevent the clogging of the conduit and its attendant flooding. This sump is cleaned out as needed (see illustration).

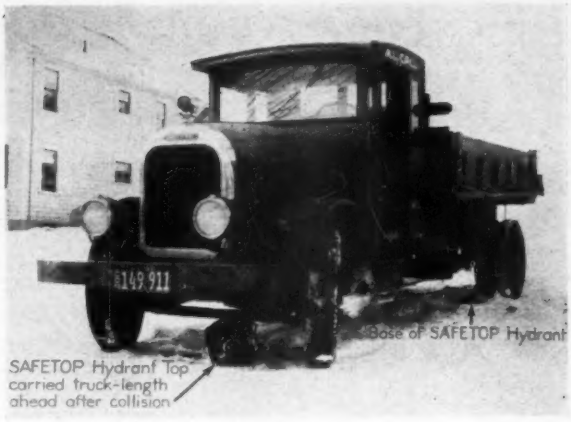
So far the improvement has proved itself a very satisfactory means of obviating conditions which formerly existed. Flooding has been stopped and the open stream enclosed and devoted to additional lawn space by the abutting property owners.

▼

Truck Test on New Fire Hydrant

Executives of the Water and Fire Department of the city of Cortland, N. Y., recently witnessed a somewhat exciting made-to-order accident which was arranged by the Kennedy Valve Mfg. Co. to demonstrate the features of their new Safetop fire hydrant. A truck driver was induced to drive deliberately against the hydrant with sufficient force to break it.

The hydrant was under full water pressure of about 83 lb. per square inch at the time of the collision, and the 5-ton truck hit the hydrant while traveling at about



Fire Hydrant Deliberately Broken by Truck

15 miles per hour. Quite a little snow was on the ground from a late spring storm, and the conditions of impact duplicated a typical accident of this nature.

As the spectators watched rather breathlessly, the heavy truck bore down upon the hydrant, and with a sharp snap, the patented safety breakable section broke cleanly, releasing the top section of the hydrant. The momentum of the truck carried it almost a full length beyond, and the truck stopped with one of its rear wheels almost directly over the lower section of the hydrant, and with the top hydrant section caught under the front axle. The bumper of the truck was bent by the collision, but no other damage result to the vehicle and the driver was uninjured.

A photograph made immediately after the truck came to a stop shows that in spite of the full water pressure on the hydrant valve, there was absolutely no leakage of water. The only parts which broke were a cast iron screwed breaking ring which joined the upper and lower sections of the hydrant standpipe, and a coupling which was pinned to the upper and lower sections of the stem. The fractures of both of these parts were found to be remarkably clean, and the top section of the hydrant, which had been carried along by the front axle of the truck, was entirely undamaged.

The truck was backed away, and the Kennedy representatives then proceeded to demonstrate the speed with which the hydrant could be returned to service. Meanwhile, the Cortland city officials timed the successive steps in repairing the hydrant.

Working at a normal rate, the repair man put on a new breaking ring and coupling—all within 12 minutes—and the fire hydrant was again ready for service.

Throughout the process of reassembly, the hydrant valve remained perfectly tight, being held snugly against its seat by the water pressure in the main. There was no necessity of shutting off the water supply. No excavating was necessary.

After reassembly, the hydrant was operated to make sure that it functioned properly. The standpipe assembly was found to be thoroughly leak-proof and rigid, and the combination stem controlled the valve perfectly, acting exactly as a one-piece stem.

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MICHIGAN CONFERENCE ON WATER PURIFICATION—The 1932 Michigan conference on water purification will be held Oct. 5, 6, and 7th, at Medea Hotel, Mt. Clemens, Mich. John M. Helper, Lansing, Mich., is secretary.

EDITORIALS

Activated Carbon and Diamond Dust

NOW with the increasing use of activated carbon for water purification, and the introduction of several activated carbons on the market for use in water purification, it is essential that something more than appearance, fineness, purity and cost be used in deciding upon the preferred material for the problem at hand. Diamond dust is essentially pure carbon but it can not prevent or remove tastes and odors.

No other water works chemical is subject to as radical difference in characteristics as may likely prove the case with various carbons. One product may be much purer than another, or it may be more finelly pulverized and yet the less pure product may have properties requisite in water purification efficiency and economy which renders it superior to the purer product. It is possible that the reverse may prove true, but it so happens that experience has shown, as was the case at Saginaw, Mich., that even under severe conditions the less pure and least costly product of the three grades supplied by one manufacturer, proved equally as effective and considerably more economical in removing tastes than was the case with the purer carbon. There are parallel observations on record in respect to the power of two different grades of carbon in respect to their ability to remove excess chlorine. Why this was true is without explanation. Further, experience has indicated that a denser carbon that does not remain in suspension as long as another may prove just as satisfactory under certain conditions as a lighter material.

Aside from all other properties of activated carbons there is one property that must outweigh all others when everything else is equal: That is its power to absorb or adsorb from the water, taste *producing* matters, or more particularly taste *creating* matters. It must be these qualities that will decide the selection of activated carbons in the future. Taste *creating* matters are the more important of the two and chemists must devise methods for evaluating the comparative capacity of various carbons and other chemicals or compounds offered, in respect to their relative ability to remove not only potential taste producing matters but more particularly, tastes already existing.

Ammonia applied to water ahead of the chlorine, or in combination with it to produce chloramine, has been fairly definitely established as an effective and economical means of preventing the *production* of a taste when a material such as phenol is present in the water supply in quantity sufficient to establish a taste when chlorine is later applied. Aside from this, it possesses other advantages not inherent with carbon. The failures during trials of the ammonia-chlorine combination have been chargeable to the fact that compounds of disagreeable taste were already present in the water prior to any treatment and ammoniation failed to rectify such a condition. The rapid increase in the use of activated carbon has come about largely as the result of its ability to remove that which other processes had not been able to cope with.

The most important problem of taste removal exists in connection with the great mass of our water supplies taken from impounding reservoirs in which decaying organic matter or algae have produced tastes and odors, or from streams draining areas in which vegetable putrifaction and decaying algae seasonally exist. On this score it seems doubtful that the tests applied to evaluate taste corrective products should be limited to their capacity of removing phenols only from the water. It is probably equally important that the test be extended to include its powers of adsorption of selected essential oils or a synthetic mixture of several oils or end-products of decay made up to represent what might be expected in the way of a natural water badly infested with taste creating compounds originating from natural biological circumstances.

It may be that, somewhere, the relationship between the power of a given carbon to absorb phenols and its power to remove hetrogeneous tastes and odors from waters has been established. If not, then until such a relationship has been established it is here suggested that one should also evaluate carbons, clays and other taste *removal* products, on their comparative efficacy in removing other more widespread and naturally occurring compounds than the phenols. In this, the manufacturers of such materials, with their experience in the application of activated carbon and clay for many and varied purposes, would do well to come forward with suggested test methods for consideration by the newly established Committee in the American Water Works Association that is charged with the selection of approved methods for evaluating the available taste correctives and taste removal processes.

In evaluating taste removal materials chemical and physical analyses are insufficient—the answer is to be found in determining the least pounds per million gallons of a given product that will remove the maximum amount of a given taste or odor. This figure multiplied by the cents per pound is the correct index. A test simpler than the phenol adsorption test, and perhaps more revealing, is sorely needed for "every day" use in evaluating taste removal products.

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London and Lancaster

ON another page in this issue John D. Watson, a prominent English sanitarian, in addressing a group of engineers attending a dinner given in his honor, tells of the $30,000,000 sewerage project under development in the environs of London. He remarked that it was essential that the work be pushed through at a prescribed rate in order to make full use of a grant for unemployment relief which would amount to about one-half the total cost of the project. The question is, does England consider this sewerage project as a "self-supporting" or "revenue producing" development? Or is England proceeding to relieve unemployment and stimulate business in a public utility and public works program financed from public funds? In either event a large sewerage project is under way in the environs of London and unemployment is thus decreased and business is stimulated.

Lancaster, N. Y., a short time ago found itself faced with the necessity of repairing and remodeling a badly leaking sewer and an overloaded and deficient sewage treatment works. The city secured a grant of $10,000 from the State Emergency Relief Fund which it used to revamp the sewerage system and to relieve unemployment. Lancaster's lead can be followed by other towns.

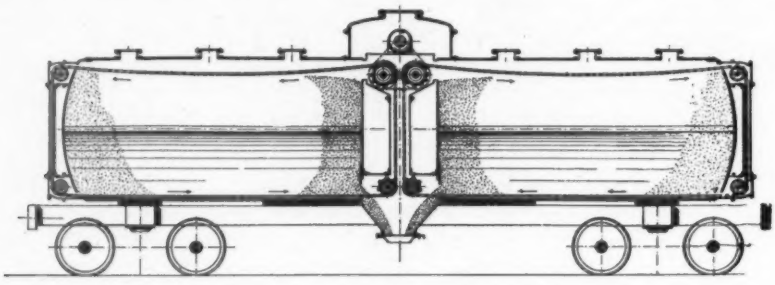
NEW EQUIPMENT

New Type Car for Use in Shipment of Water Works Chemicals

The General American Tank Car Corporation announces that it has perfected a unique car known as the Dry-Flo tank car, which handles granular commodities as conveniently and efficiently as standard tank cars now handle liquid commodities.

This car, which conforms to all the requirements of the American Railway Association, has been enthusiastically received by those who have had it in trial service, and it is believed will result in material transportation savings and increased simplification in handling dry chemicals.

A few of the products for which the Dry-Flo car was designed are cement, lime, silica sands, flour, sulphur, fertilizers, cleaning compounds, soda ash, alum, copperas, copper sulphate, pottery clays, etc. The final production of this car represents almost two years of research and road tests by the General American Tank Car Corporation's Engineering and Research Department. Only after extensive development and thousands of miles of trial trips has this car been perfected to a point where it can be made available to American industries. General American has now made it possible to carry dry commodities with practically the same ease that liquids have been transported in bulk.



Sectional Drawing of "Dry-Flo" Tank Car for Shipment of Chemicals

It has been discovered in these days that low cost of transportation alone will not necessarily keep business on our railroads. Convenience is just as essential, and the remarkable convenience of this new car is sufficient to bring back to the railroads many attractive movements of granular commodities in bulk.

The practice today has been to ship dry granular materials in packages, or if shipped in bulk, to handle them by the old-fashioned shovel and wheel-barrow methods. Such ladings are of sufficient volume to warrant the installation of equipment in the car to handle these commodities in bulk.

This absolutely water tight car is provided with a single outlet at the bottom through which the bulk contents of the car are uniformly unloaded at a rate best adapted for subsequent handling by a simple conveying equipment.

The new carrier eliminates two or more handling operations, and because of these economies is expected to exert a far reaching influence in the marketing of products such as listed above. Savings as high as $2.00 a ton in shipping costs have been reported during the test period.

The operation of the new car is very simple. Drag chain conveyors are supplied which are drawn from each end towards the center of the car. The material shipped is pulled along with the chains and dropped from the chains into the discharge opening at the center bottom. The chains continue upward and back across the top of the car to the ends.

Dry commodities tend to pack and arch. They are of widely varying nature and weights, and therefore the car had to be designed and perfected with an effective but very sturdy unloading mechanism, the operation and maintenance of which would be extremely simple and foolproof. The car entirely eliminates the dust nuisance, the losses which have been, up to now, present in the transportation of dry commodities, and have necessitated the high cost of packaging.

The development of the Dry-Flo car is another evidence of General American's cooperative effort with the railroads to supply the most efficient and economical transportation methods, and to increase the volume of transportation of commodities in bulk over the rails. Among the many cars which have been developed and perfected by the company which have brought amazing changes and savings into American industries, none is considered more important and more far reaching in its effects than this present one.

As one of the results of this development, for example, a large contracting company has decided to use these cars rather than use motor trucks for transporting cement from the cement producing plants to their mixing plants.

Another shipper who has been using hydrated lime in his manufacturing processes instead of the cheaper and more efficient quick lime, on account of the danger to workmen with the latter, finds that since lime in a Dry-Flo car does not come in contact with human hands he can now substitute quick lime with a very impressive saving at the end of the year. There are other similar applications which must be of interest in the water works and sewerage field.

For more detailed information and as to rental charge on the "Dry-Flo" car address the General American Tank Car Corporation, New York City or Chicago.

WITH THE MANUFACTURERS

J. P. Harris Elected Vice-President American Oil Chemists

John P. Harris, chemical engineer and senior member of the technical staff of the Industrial Chemical Sales Co., Inc., New York, manufacturers of Aqua Nuchar, was

John P. Harris

elected to the office of first vice-president, American Oil Chemists' Society, meeting in convention at New Orleans, May 13. Mr. Harris is well known for his articles appearing regularly in the technical and trade journals on the subject of oils, fats and related products and at one time served as the director of practical research for the Institute of American Meat Packers.

Kenneth Shibley—Organizes The Shibley Company

Kenneth Shibley, formerly manager for California Filter Company, has been appointed manager of Shibley Company, Incorporated, with offices on the seventh floor, Textile Tower, Seventh and Olive street, Seattle, Wash.

The Shibley Company is engaged in the water purification business in all its branches, including filtration, softening, sterilization, special industrial uses, swimming pools, and water recovery problems.

This company will represent:

Wallace & Tiernan Co., Inc., of Newark, N. J.; Builders' Iron Foundry, of Providence, R. I.; Hall Laboratories, Incorporated, of Pittsburgh, Pa.; Hagan Corporation of Pittsburgh, Pa., and the Cement Wrapped Pipe Company, Limited, of San Francisco, Calif.

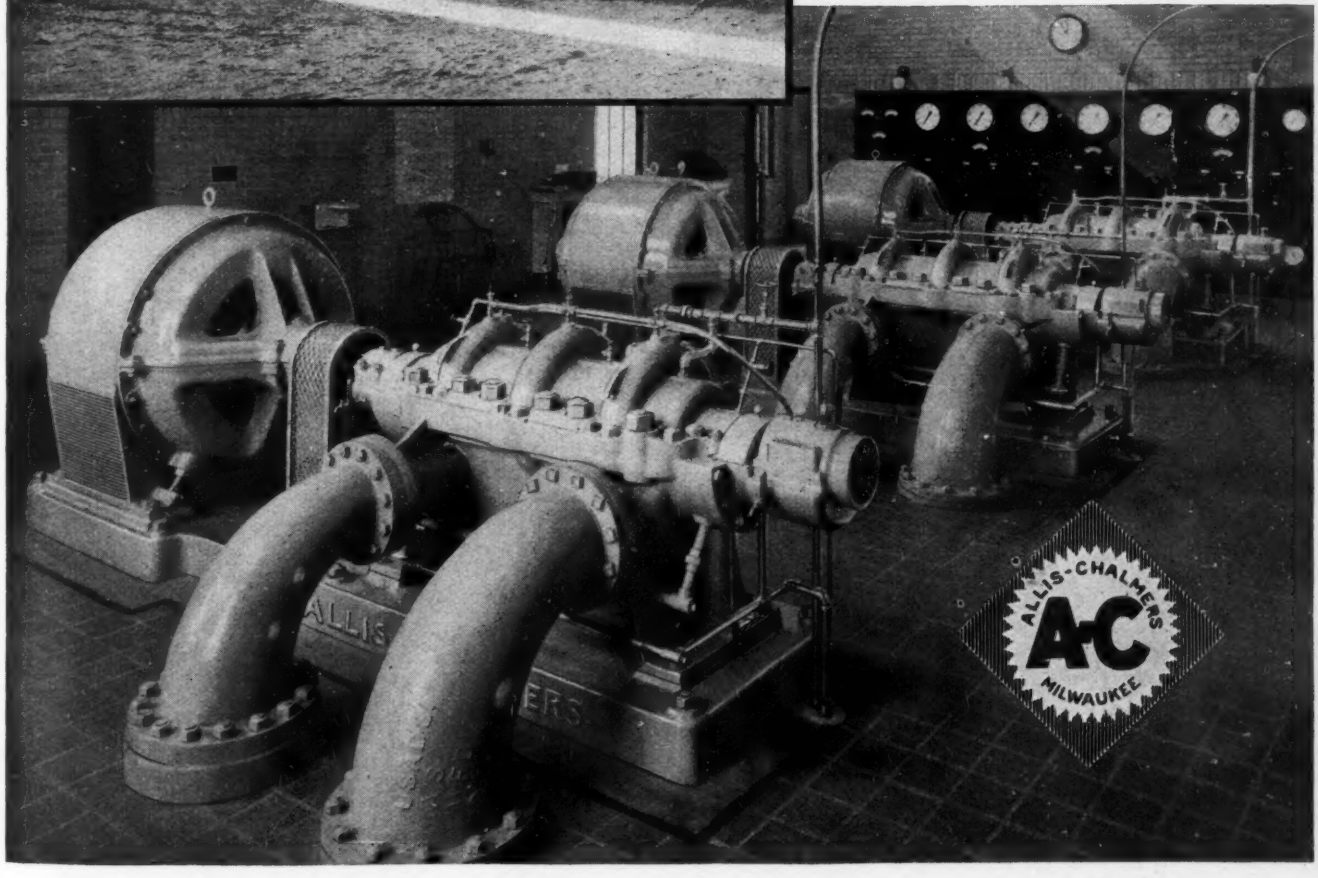
J. Wrench Sails for Europe

Mr. J. Wrench, sales manager and treasurer of Industrial Chemical Sales Company, Inc., leaves for Europe on July 2, SS. "Brittanic." He will be away for two months, during which time he will visit agents in the principal European cities.

FOR HIGH PRESSURE FIRE SERVICE . . .

The City of Milwaukee High Pressure Fire Service Pumping Station, was recently put in operation with Allis-Chalmers double suction high efficiency Type "M" Centrifugal Pumps and Allis-Chalmers Induction Motors. Allis-Chalmers Mfg. Co. has been furnishing equipment for fire service pumping stations, using motor driven centrifugal pumps, since 1906 and present designs embody the results of the twenty-six years experience.

Allis-Chalmers Mfg. Company
Milwaukee, Wisconsin



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Cast Iron Pipe

Bell and Spigot type
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Long Lengths

McWane Precalked Joints or Open Bell
Sizes: 1¼ thru 12 inches. Fittings.

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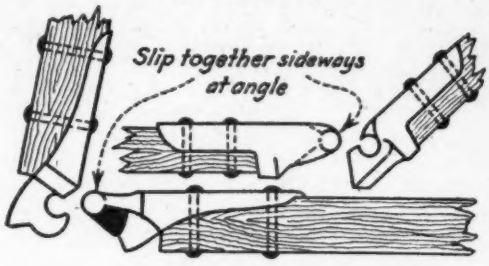
Water Cleaning System, if you wish it, or Drag Bucket type.

WE WILL PAY FREIGHT AND CHARGE TO BILL.

We Ship Rods for Trial—who else will do this?

We also make a Rod that will float. Also rods with wheels for conduit work.



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POSITIONS WANTED

This department has been started as a service to those in the Water Works and and Sewerage Fields. We hope they will make use of it. The notices are inserted without charge.

EXPERIENCED DESIGNER on waterworks and sewerage. Have been with some of the country's leading sanitary engineering firms. Age 37. Married. Assoc. Mem. of American Society of Civil Engineers and Member of A. W. W. A. Have been in responsible charge of design. Box 6010, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

ENGINEER-CHEMIST—Age 35; ten years with city of 36,000 population in charge of water, light and sewer systems, water filtration and two modern sewage treatment plants. Desires position as superintendent, assistant superintendent or plant superintendent. Box 5020, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

MARRIED MAN, 36 years old, with 13 years' experience in water purification plant control and operation, also experienced in water meter repairing and testing. Best of references can be furnished. Box 5010, Water Works and Sewerage, 420 Lexington Ave., New York City.

MECHANICAL ENGINEER, experienced on design and construction of sewage plants and equipment. Has handled number of men on plant layout and design, including mechanical, electrical, structural, concrete, piping and machine design draftsmen. Recently supervised construction of mechanical-chemical sewage plant of Dearborn, Mich. Hard, conscientious, efficient, expert worker. Box 6006, Water Works and Sewerage, 420 Lexington Ave., New York City.

M. A. IN CHEMISTRY from prominent university wants position as chemist or plant operator. Over three years' experience as chemist, chiefly on water and foods. Age 26. Any location. Moderate salary. Good references. Box 6002, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

SUPERINTENDENT CHEMIST — Position wanted by man thoroughly familiar with filter plant operation and water softening. Has eight years of laboratory experience, four years' experience in filter plant operation and four years as superintendent of water works in town of 15,000. Address "P. C. L." % Water Works and Sewerage, 420 Lexington Ave., New York City.

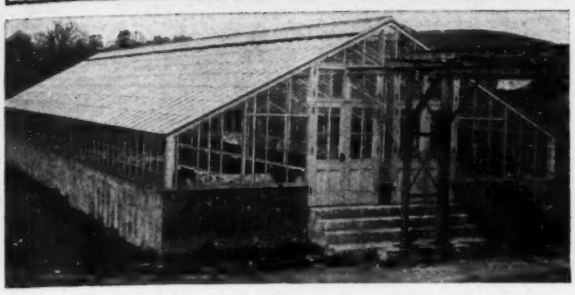
WATER CHEMIST AND BACTERIOLOGIST—Ph. B. in chemistry. Five years sanitary chemist, State Dept. of Health. Seven years in charge of purification and sanitation of large eastern water supply. References. Available immediately. Location immaterial. Married. Age 36. Box 6008, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

WATER CHEMIST — B. A. in chemistry from well known university. Two and one-half years' chemical and bacteriological experience as first assistant in state health department laboratory. Have had practical experience in water plant operation and supervision. Available immediately. Excellent references. Single. Age 25. Box 5000, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

EXPERT on sewage and industrial wastes disposal and stream pollution with ten years' experience and accumulated data. Formerly connected with largest disposal program in U. S. Qualified to investigate, study, report, design, supervise operation, construction, take charge or advise on all phases of sewage disposal. Permanent or temporary work desired. Box 6012, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

WATER WORKS designing, construction and operating engineer. Member A. S. C. E. Twenty-seven years' experience in design and construction of filter plants, water softening plants, dams, tanks, pipe lines, etc., with utility companies building and operating water plants. Location anywhere. Married. Age 48, and perfect health. Best references. Box 6004, Water Works and Sewerage, 400 W. Madison St., Chicago, Ill.

Glass-Overs for Sludge Beds



Facts Concerning the Disposal System at New Lexington, Ohio

Plant is designed to treat an average flow of 500,000 gallons per day, serving a population of 5,000. The Lord & Burnham Sludge Bed Glass-Over speeds up the drying of the sludge. The city has passed a sewer rental law whereby each household, industry and public building, is charged for the services rendered by the sewerage system and sewage disposal plant, thus providing operating funds for this purpose. The Glass-Over itself, is the latest in design and construction, giving quick-drying results and insuring long life to the structure. No other construction has the same proven practicalness and endurance. Send for full particulars.

Lord & Burnham Co.

SLUDGE BED GLASS-OVERS

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LAUGHLIN TRAVELLING SCREENS

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SEWAGE WATER AND INDUSTRIAL PRODUCTS

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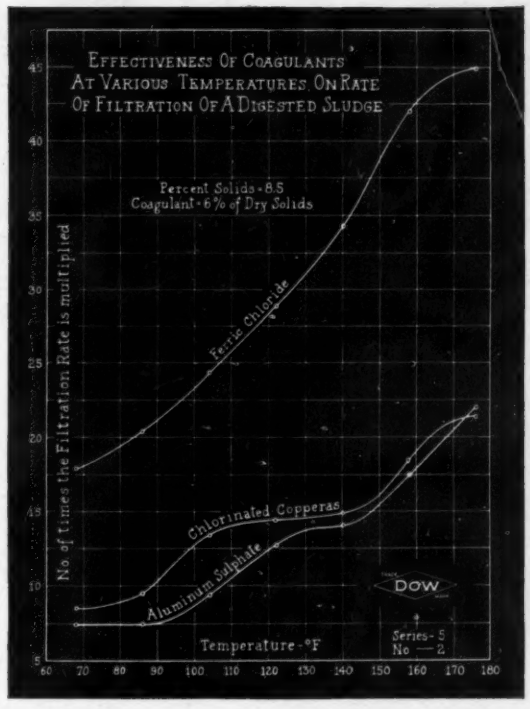
Heat increases effectiveness of

DOW FERRIC CHLORIDE COAGULANT

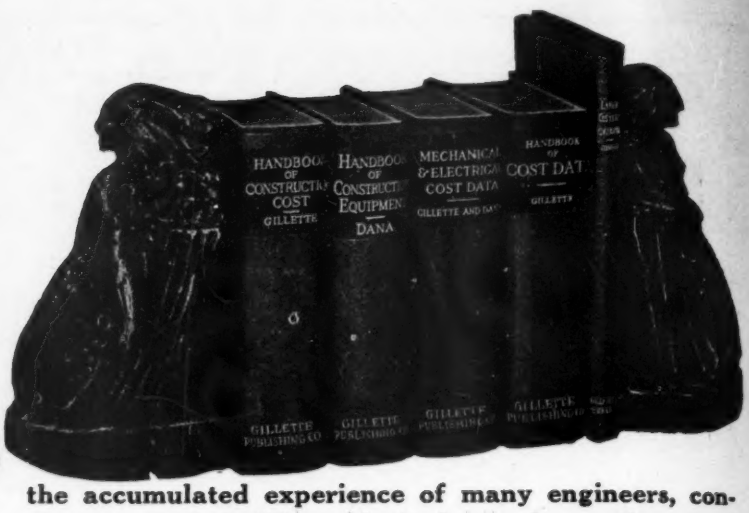


THE filtration rate of digested sewage sludge treated with a coagulant can be further increased by the application of heat as shown in the above graph. The sludge tested, treated with 6% Ferric Chloride (basis dry solids in sludge), filtered 17 times faster than untreated sludge. An increase in temperature to 130° Fahrenheit almost doubled this filtration rate. Compared with the other two coagulants tested, sludge treated with Ferric Chloride filtered more than twice as fast. *Ferric Chloride* is the *most effective* and *economical coagulant* to use.

Investigate Dow Ferric Chloride Coagulant for sewage disposal and water purification plants. Write for additional information and prices.

THE DOW CHEMICAL COMPANY

MIDLAND, MICHIGAN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HANDBOOK OF CONSTRUCTION EQUIPMENT — DANA
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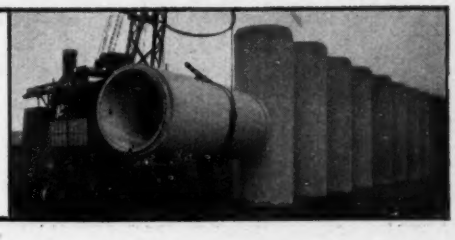

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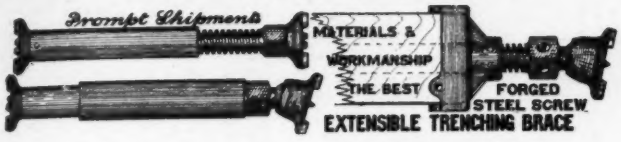

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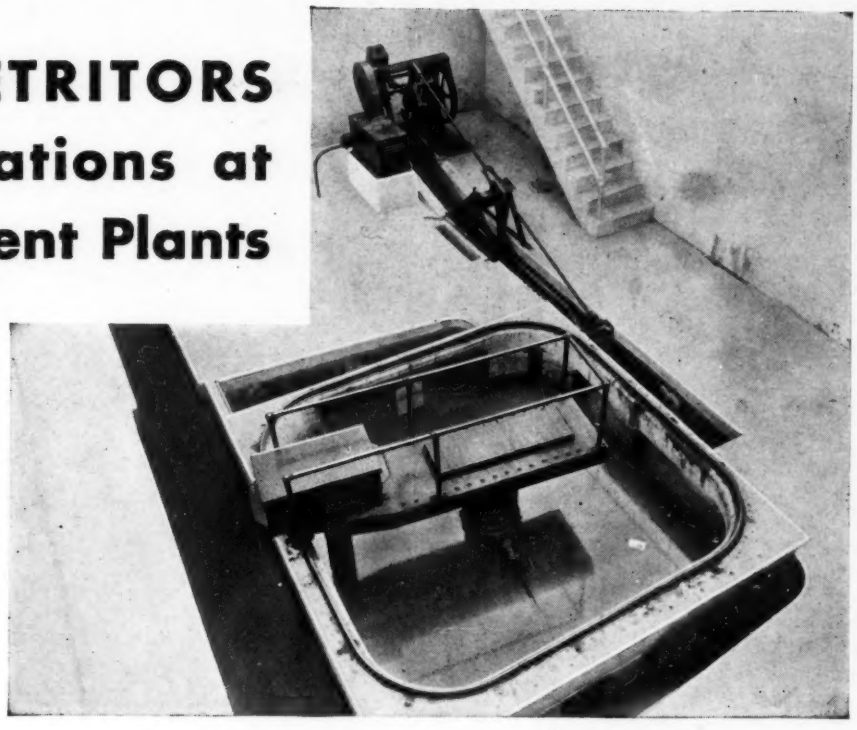

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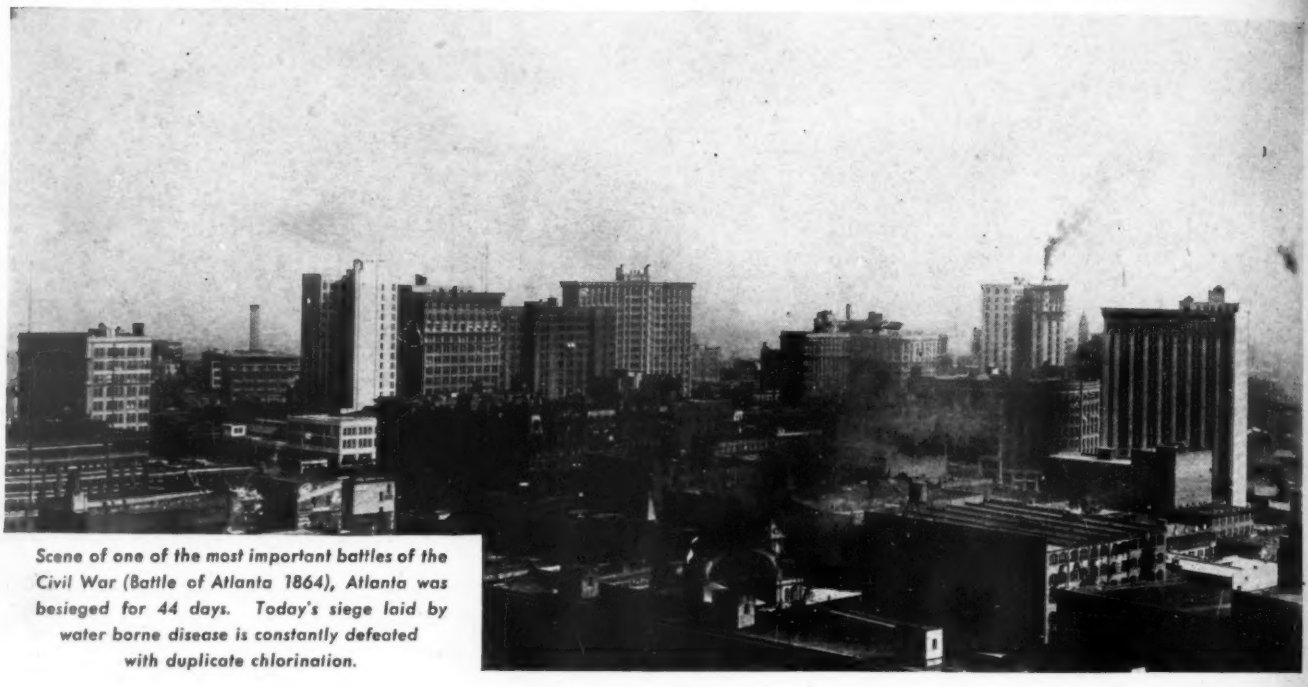

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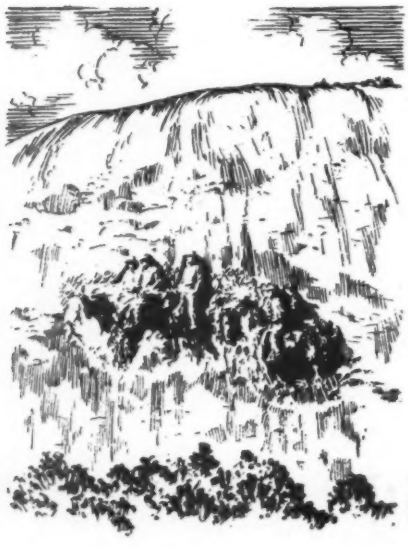

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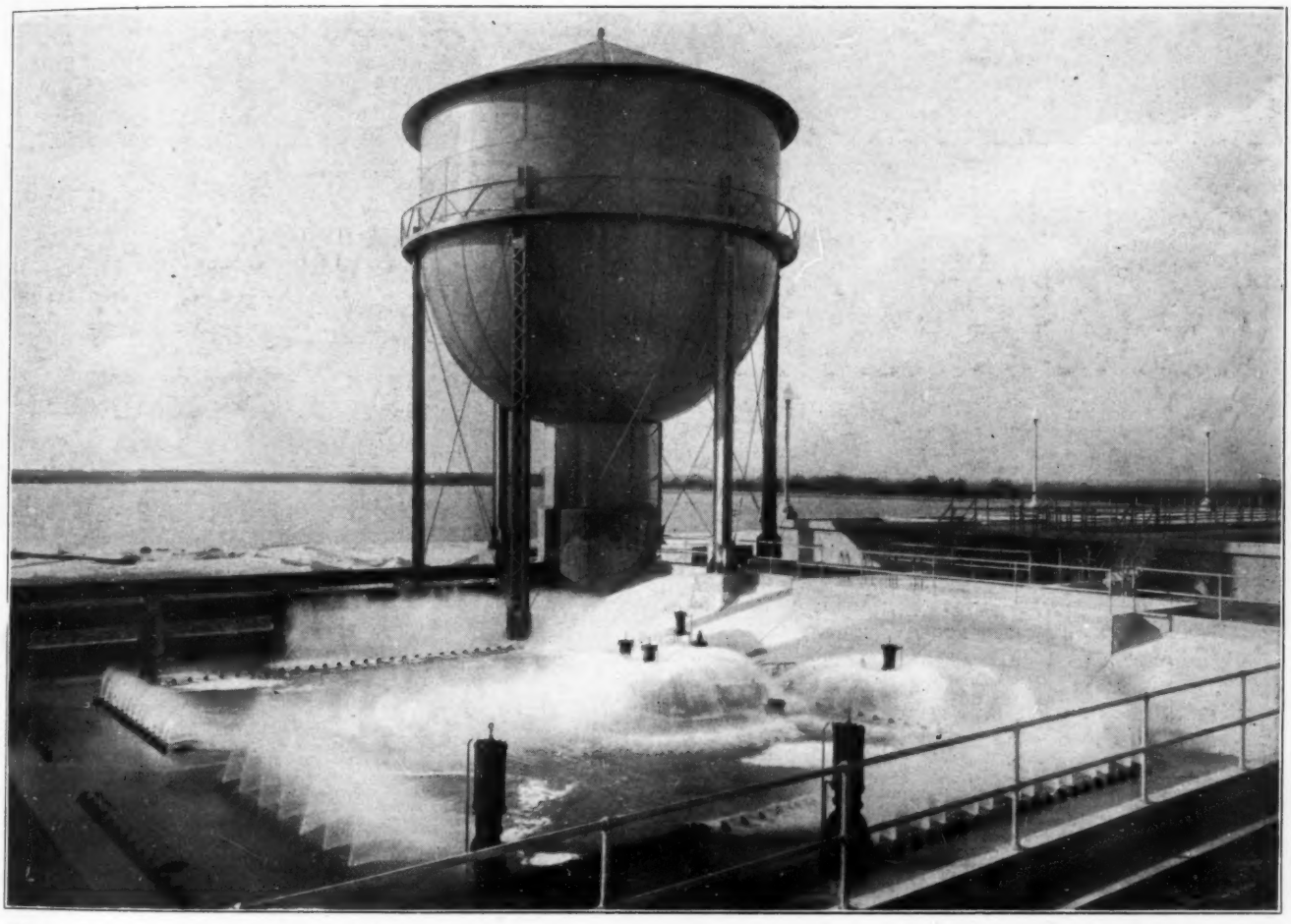

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Detecting Rate of Corrosion

Water Supply Improvements at Farmington, Conn.

Operating Results of Five Sewage Treatment Plants

Reports of Meetings of Pennsylvania Water Works Operators and Pennsylvania Sewage Works Association

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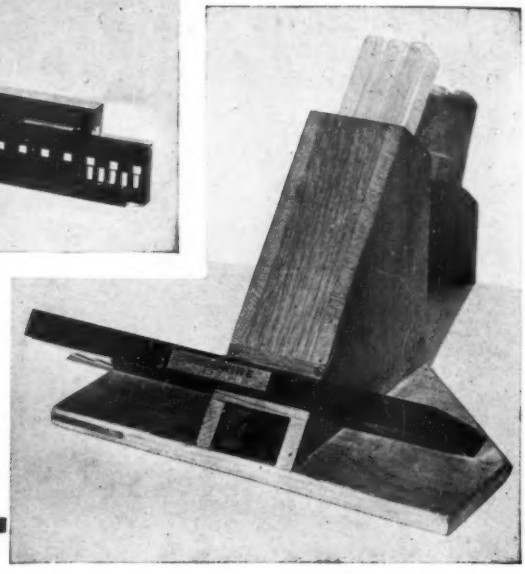

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